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■ CANADIAN MUSEUM OF NATURE ■

Global biodiversity

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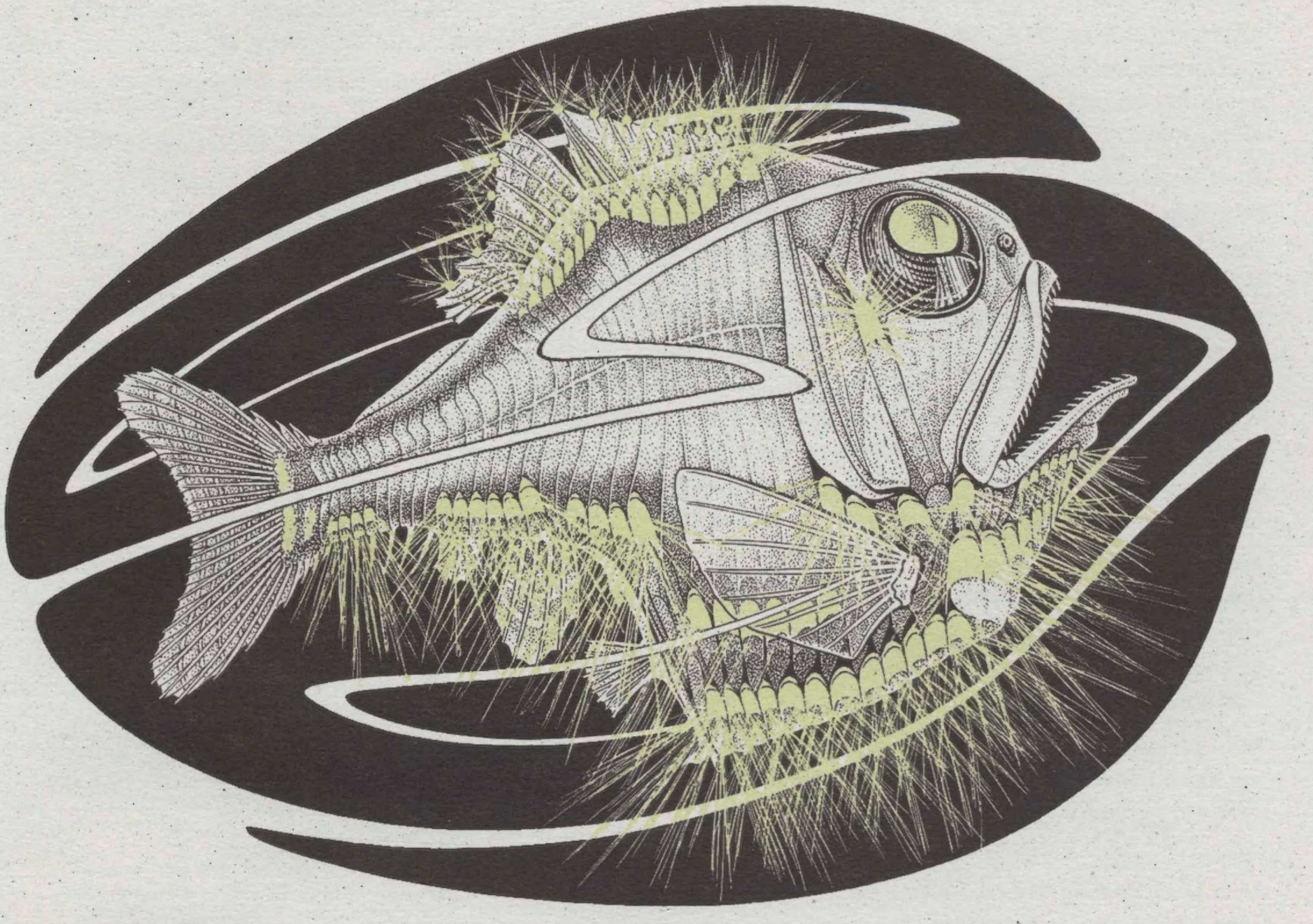
research, conservation and wise use



TURNING THE TIDE

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THE PARADOX OF PARASITES

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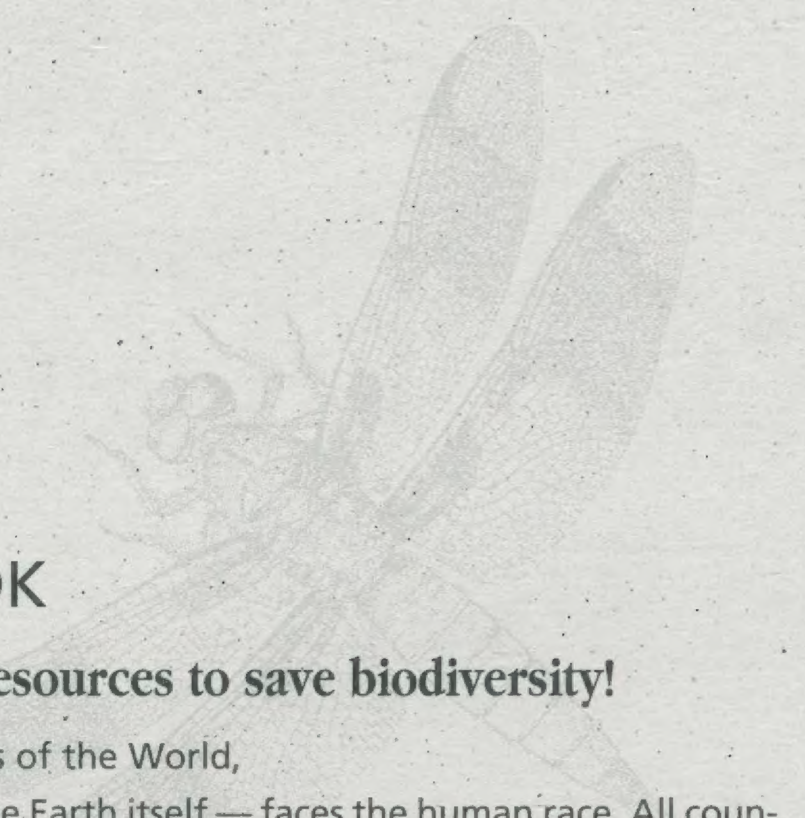

EDITOR'S NOTEBOOK

Absolutely no shortage of resources to save biodiversity!

Dear Prime Ministers and Presidents of the World,

An array of problems — as vast as the Earth itself — faces the human race. All countries face the problems that surround the survival of the variety of life on land, in freshwater, and in the oceans. The good news is that there is no shortage of human or financial resources.

There is the energy and enthusiasm of youth, the experience of our elders, the knowledge of scientists, the wisdom of indigenous peoples. For the most part, these human resources are lying fallow, wasted as the Earth's biodiversity dwindles from human impacts. In the North, ultraconservative governments have been slashing the staff of environment and resource departments. These staffs have decades of knowledge; they want work. Educated but disheartened, young people are unable to find employment; their jobs have been sacrificed to the gods of Globalization, Efficiency, and Stockholder Returns. In the South, unemployment is rampant, even for skilled workers. Millions are drafted to fight for their country or are dragged into civil wars. In both the South and the North, retired people want to contribute. The problem, then, is not lack of people.

Around the world, immense sums of money flow into gold and diamond mines (some fictional); enormous hydroelectric projects; costly weapons systems, fighter planes, warships, and millions of land mines; currency juggling games; and material goods that do not improve the quality of life. The problem, then, is not lack of money.

Prime Ministers and Presidents, will you please explain to my grandchild: "Why are we wasting these talents and resources? Why aren't we waging peace with the environment instead of war on people and the planet?"

There are huge numbers of people on this planet who are crying for meaningful work, work that will let them lay their heads down each night with satisfaction and go to their final resting place knowing that they have accomplished something for their children and the planet. Let us mobilize in a campaign that will make the world wars seem like puppet plays. Let us act so that this era in history will be known as the beginning of intelligent life on Earth.

Don E. McAllister

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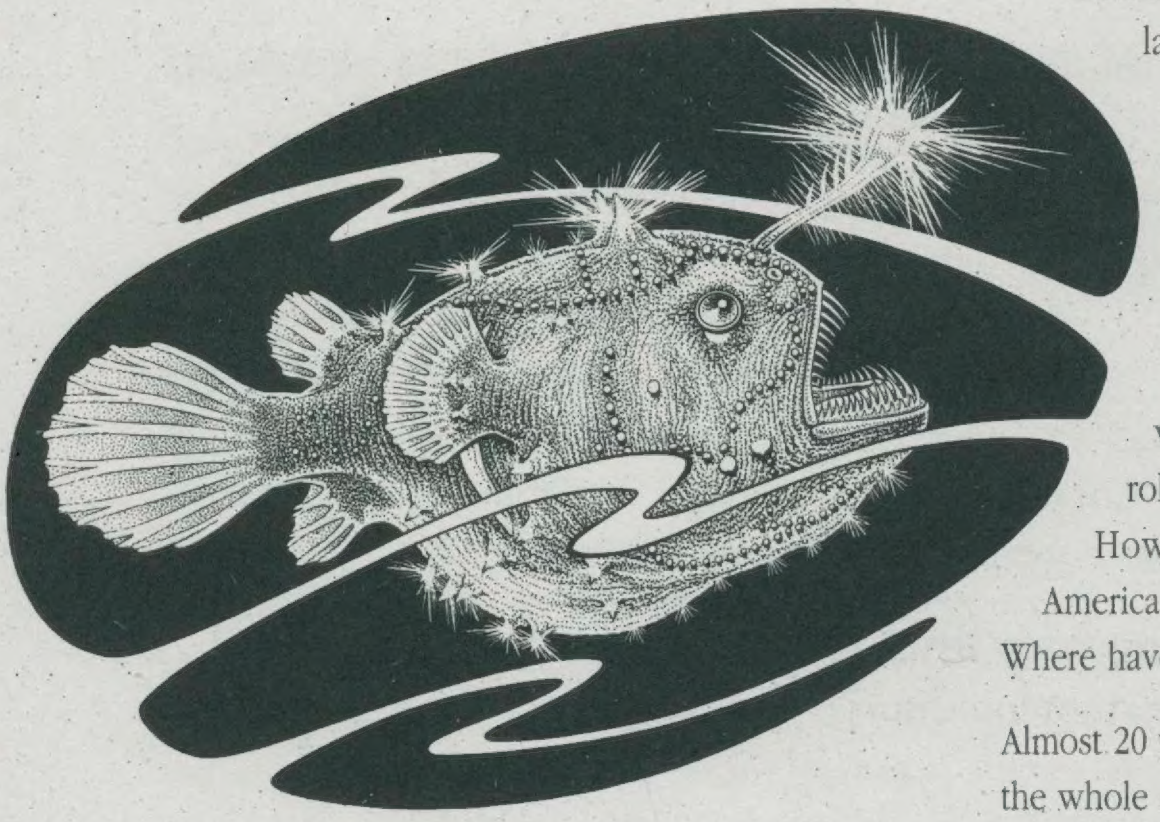
CANADIAN MUSEUM OF NATURE

Turning the tide

Conservation biology has stayed on dry land at the expense of the other 99% of the Earth's habitat.

by Amy Mathews Amos



Lightlamp football fish, *Himantolupus groenlardians*

It used to be that "out of sight, out of mind" seemed to work: being terrestrial creatures, we focused our ecological research and conservation efforts largely on the land, and assumed that the vast expanse of open ocean could absorb literally whatever we threw at it. But the decline of marine ecosystems has become more apparent in recent years, and vivid images of dying dolphins and unemployed fishers are hard to ignore. Unfortunately, our landlubber history has left us with a legacy of ignorance and we are unprepared to address the problems we find ourselves facing with increasing frequency. Why are toxic red tides increasing? What role will global climate change play in widespread coral bleaching? How do we limit or control harmful alien invaders, such as the American Comb Jelly, *Mnemiopsis leidyi*, that has taken over the Black Sea? Where have all the fish gone?

Almost 20 years ago a small group of ecologists with foresight recognized that the whole of scientific knowledge on conserving biological diversity would be greater than the sum of its parts or disciplines. Unless the disciplines of ecology, biogeography, population genetics, zoology, botany, and so on were put together, little progress would be made in conservation. The results of that epiphany were the first symposium on conservation biology in 1978 in San Diego, California, US and the first book on conservation biology in 1980 (Soulé and Wilcox 1980). Since then, conservation biology has grown as a science, with its own journal and over 5,000 members in the Society for Conservation Biology.

But in the course of uniting the natural science community on conservation questions, and creating a scientific discipline accepted within the halls of academia, conservation biologists gave in to their terrestrial tendencies and overlooked marine biological diversity as a critical area of study central to our survival. A recent review of *Conservation Biology* revealed that there were 13 times as many articles on terrestrial species and ecosystems as on marine (Irish and Norse 1995).

We can no longer afford this terrestrial bias. Consider the fact that roughly 70% of the world's population lives in coastal areas. With a burgeoning human population, coastal pressures will likely increase rapidly in the coming decades. More pollution enters marine waters from land-based activities than from any other source (World Resources Institute 1994), including agricultural runoff, sewage, sediments from construction and deforestation, and airborne emissions. This land-based pollution can only worsen as human population

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"The deep sea and its species still remain virtually unknown."

grows. Fish and shellfish together make up the single largest source of animal protein in the world, yet news reports of algal blooms, smothered reefs, diseased marine mammals, and depleted fisheries sprinkle our front pages routinely. With increasing pressures this sprinkle could soon become a flood.

We need answers and we need action. Scientists need to provide the answers so that conservationists and decision-makers can take action. We need to increase our scientific understanding of the causes and consequences of the symptoms of decline in marine ecosystems that we are now seeing. We need, in other words, a new science of marine conservation biology to focus scientific research on conserving biological diversity in the sea.

A SEA CHANGE IN THE SCIENTIFIC COMMUNITY The key to success, at least initially, lies within the scientific community. As with most traditional scientific disciplines, marine scientists work within narrow fields of study and are rewarded for staying within the lines. Certain types of pure research are considered more prestigious than applied sciences, and are more likely to be recognized within the halls of academia. But Monet, Matisse, and Picasso never got anywhere staying within the lines, and neither did terrestrial conservation biologists. As on land, significant advances at sea are most likely to come from new interactions of old disciplines. For example, fisheries biologists with their recruitment and mortality population models of targeted species may not consider the effects of changes in interspecific competition and predator-prey interactions, which can result from heavy fishing activities, or the effects of habitat losses from mobile gear. Yet some marine ecologists and ichthyologists could probably shed some light on that, potentially improving fisheries predictions and protection of biodiversity.

Despite the inertia, the scientific community is beginning to respond. In 1995 the National Research Council (NRC) in the United States published *Understanding Marine Biodiversity*, which outlines a research agenda to improve our understanding of the effects of human activities on marine biodiversity. As noted in the report, "[e]valuating the scale and consequences of changes in the ocean's biodiversity due to human activities is...seriously compromised by critically inadequate knowledge of the patterns and the basic processes that control the diversity of life in the sea." For example, how many species live in the deep sea? A series of papers by J. Grassle, and the responses to them, have raised the issue but have not provided a solution to the problem of species richness in this ecosystem, which remains virtually unknown and almost totally unrepresented in marine protected areas. And yet the deep sea represents half of the Earth's area (McAllister 1995a, 1995b).

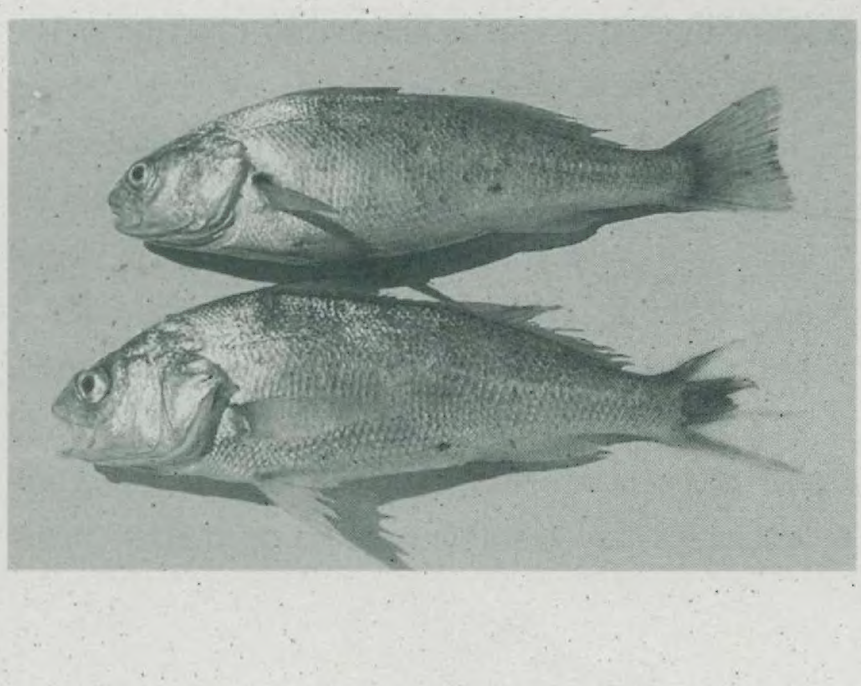
Among the stated objectives of NRC's research agenda for marine biodiversity are:

- to understand the patterns, processes, and consequences of changing marine biological diversity;
- to improve predictions of the impacts of human activities on the marine environment; and
- to improve the linkages between the marine ecological and oceanographic sciences.

Indeed, the introduction of the report states that ecological and oceanographic research should be integrated at all relevant spatial and time scales to distinguish changes in biodiversity due to effects of human activities.

NRC stressed the importance of systematics and taxonomic expertise in achieving its objectives. The "graying" of taxonomists was noted as a serious concern — taxonomists specializing in taxa of ecological importance have retired or died and few younger scientists are being trained to replace them. The report notes that the impact of human activities on diversity is difficult to assess at all in systems where species diversity is so poorly known and many species and groups of higher taxa remain undescribed. In addition, the report recommends that taxonomists and ecologists "begin speaking the same language," meaning that taxonomists need to receive more training in ecology, and ecologists need to learn more taxonomy. The 1996 Global Biodiversity Forum (GBF) in Montreal, Quebec, Canada drew attention to the need for a global hierarchic marine ecosystem classification system and to the model provided by F. Paul Holthus and James E. Maragos (1995). The GBF also fostered the ecosystem-based approach to fisheries management. But how can we possibly classify marine ecosystems if experienced systematists and taxonomists do not exist? Clearly, the fields of taxonomy and systematics need to be rejuvenated if we are to improve our understanding of marine biological diversity.

The publication of the NRC's report was an important step forward. Another significant indication of the increasing awareness of marine biodiversity within the scientific community was the theme of this year's annual meeting of the Society for Conservation Biology held in Victoria, British Columbia (BC), Canada. The theme was "marine conservation biology," and at the meeting, the Society for Conservation Biology and Marine Conservation Biology Institute (MCBI) co-sponsored the first-ever symposium on this subject. Papers were presented by an assortment of scientists, including marine biologists and ecologists, ethologists, icthyologists and fisheries managers, social scientists, and terrestrial conservation biologists and ecologists. The interactions among more than 1,000 marine and non-marine scientists from around the world provided opportunities to consider the application of terrestrial conservation concepts to the marine environment and to share information among marine disciplines. It is expected that the first book on marine conservation biology, based on the best papers presented at this meeting, will be published sometime in 1999.



These two white croakers *(Genyonemus lineatus)* from the Inner Harbor of Los Angeles, California, US illustrate the effects of chemical pollution. The lower fish, like many caught in the same trawl, has severe fin rot. Fin rot, liver tumours and weakened immune systems are common sublethal effects in marine organisms in polluted areas. (Text and photo by Elliott A. Norse, MCBI)

The momentum is still building. MCBI is now working to continue this kind of interaction through multidisciplinary workshops on emerging topics in marine conservation biology. Workshops in 1996 and 1997 brought scientists from around the world together to discuss the effects of bottom trawling on marine ecosystems and the ecology and conservation biology of large pelagic fishes. In the first of several workshops in 1998, marine and non-marine scientists will discuss how to control established populations of alien marine species.

FISHING FOR FUNDS If federal governments were to fund the research ideas generated at symposia and workshops, the momentum would build swiftly. Unfortunately, the lines that constrain scientific inquiry in academia run through government as well.

The National Science Foundation (NSF) — the primary government funding agency of scientific research in the United States — focuses mainly on pure science or basic research within a single discipline. Most of this research is not directed towards real world situations such as conservation. For marine conservation biologists, this means that at least four different program areas (biological sciences, geosciences, polar programs, and various cross-cutting activities) might cover aspects of research related to marine conservation biology, but most of the research topics remain peripheral to marine conservation.

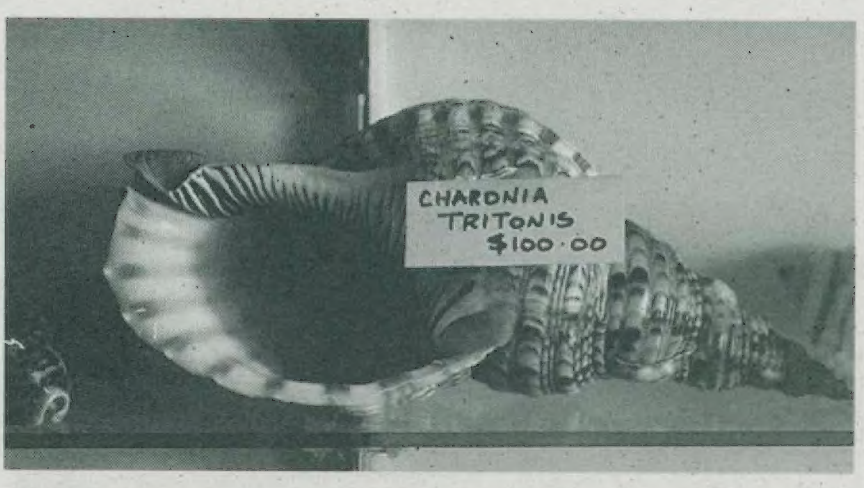
One of the best matches for marine conservation biology topics is the Biological Oceanography Program within the Ocean Sciences Research Section of the Geosciences Directorate (other programs within this section are Chemical Oceanography, Marine Geology and

Geophysics, Physical Oceanography, Oceanographic Technology and Interdisciplinary Coordination, Other Global Change Programs, and Other Research Initiatives). Because marine conservation questions are usually buried within separate program areas, there is the concern that they will become the poor stepchildren of other, often physical science questions. Such a structure also ignores marine conservation biology as an important field in and of itself.

It is true that the NSF has established some multidisciplinary programs in recent years that touch on marine conservation biology. For example, one of its current cross-cutting programs is Ecology and Oceanography of Harmful Algal Blooms. But this, like many of NSF's multidisciplinary applied programs, is a distinct interagency effort carried out with input and support from other agencies, including the US Environmental Protection Agency, the National Oceanic and Atmospheric Administration (NOAA), and the Office of Naval Research. The NSF seems unwillingly to commit itself wholeheartedly to the need for interdisciplinary applied research such as marine conservation biology.

At the other end of the spectrum, the conservation end, NOAA is a mission-oriented agency dealing with fisheries management, endangered species protection, marine sanctuaries, and coastal zone management. NOAA's strategic plan for the coming years acknowledges the need to improve integration of its research efforts and take an ecosystem approach to research that supports all of its numerous missions.

However, mission-oriented agencies such as NOAA often are forced to focus many of their limited research dollars on pressing, often narrowly defined issues directly related to their legislatively defined purpose. This doesn't provide much opportunity to examine conservation issues that are emerging on the horizon but have not yet attracted political attention or those that are not clearly connected to agency priorities.



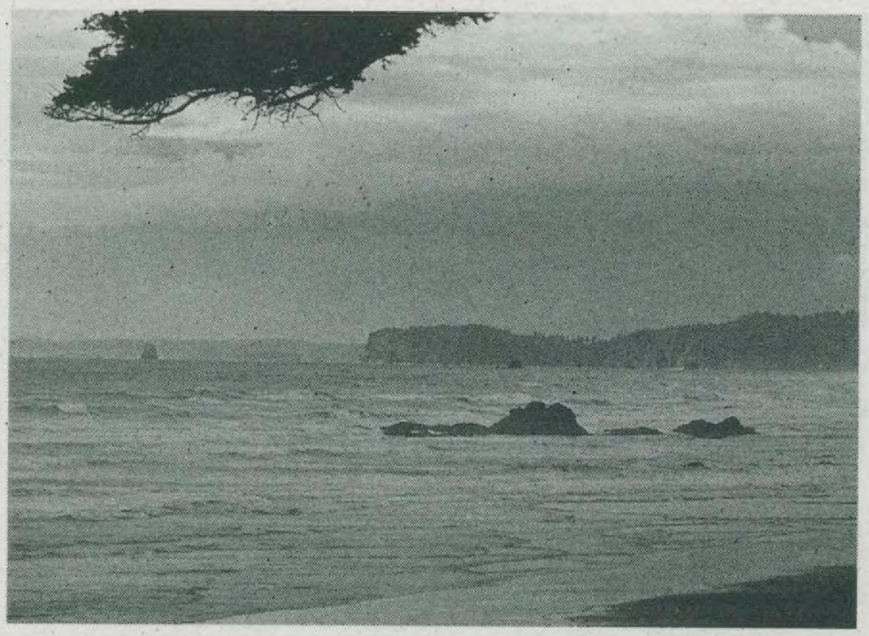
This triton's trumpet snail *(Charonia tritonis)* shell on display in a tourist curio shop in Cairns, Australia is a species with a big price on its head. In a world where the majority of the world's people live along coasts and are poor, a living triton's trumpet that sells for $100 retail might bring $5 to its collector, a sizable fraction of his or her monthly income. Protecting species with a high price on their heads (or shells) from overexploitation is a major challenge to marine conservationists. Some scientists have suggested that overcollection of this predatory snail, along with nutrient run-off from land, may be contributing to the crown of thorns starfish outbreaks on coral reefs. (Text and photo by Elliott A. Norse, MCBI)

Such a new science needs new funding mechanisms. In recent years in the US, many scientists and members of Congress have been urging the establishment of a National Institute for the Environment (NIE) to focus scientific research specifically on questions addressing environmental quality, and to fill the voids that currently exist in environmental research. As proposed, NIE would function as an independent, non-regulatory, federal science institute, and would provide funding for peer-reviewed research in the natural and social sciences, engineering, economics, and other fields where information is needed to solve pressing environmental problems. Scientific research at NIE would be based on three central questions:

- What resources do we have?
- How do environmental systems work?
- How do we maintain environmental resources and systems?

Rather than being organized by scientific disciplines, research programs would be problem-focused, and organized around major environmental problems identified by a balanced governing board of scientists, state and local government officials, environmentalists, and business people (Committee for the National Institute for the Environment 1993).

The idea is to establish an unbiased, credible source of scientific information on key questions related to protecting the environment — questions that currently are not thoroughly addressed by other government research efforts. Such an approach would provide a mechanism for exploring marine systems and human impact on those systems in a way that complements, on the one hand, the strict, pure science favoured at NSF and, on the other hand, the limited mission- or regulatory-driven approach carried out by other government agencies.



The Olympic Coast National Marine Sanctuary is a federally protected area off the west coast of the Olympic Peninsula, Washington, US. This high-energy outer coast has a sandy, cobble and rocky shore area and adjacent coastal waters host kelp forests, a remarkable diversity of starfishes, many kinds of rockfishes, substantial populations of bald eagles, sea otters, and killer whales. Marine protected areas are a crucial way to protect and restore species populations — including unknown species that scientists have yet to describe, classify, and understand — and sustain recreation and fisheries. (Text and photo by Elliott A. Norse, MCBI)

We know that current agency efforts to do it all just don't work: former EPA administrators — Reilly, Ruckelshaus, and Train — and all six former EPA assistant administrators for research and development agree that an NIE is needed to improve the scientific basis for environmental protection. In a July 1996 letter to President Clinton, these administrators noted the difficulties of trying to build an agency's scientific capabilities while simultaneously supporting regulatory requirements. However, the Clinton administration has stated that it does not see the need for structural change at this point in time.

> "A National Institute for the Environment is needed to improve the scientific basis for environmental protection."

SETTING SAIL Clearly something needs to be done because current efforts at protecting biological diversity — both marine and terrestrial — are not enough. Marine conservation biology efforts are at least two decades behind terrestrial efforts, but like a mythical sea monster emerging from the deep ocean, the mysterious marine problems now showing their faces are too alarming for scientists and policy makers to ignore any longer. Marine scientists and conservation biologists have an opportunity to address biological diversity in the other 99% of the habitat on Earth — in estuaries, coastal waters, and open ocean — and create new opportunities for research and jobs in a much needed field of inquiry. The big scientific challenge is to protect biological diversity on Earth. The first challenge is to talk to one another.

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The paradox of parasites

Fascinating in their diversity, yet often reviled, parasites are crucial to planetary health.

by David J. Marcogliese and Judith Price

Parasitism is a lifestyle whereby an individual organism (the parasite) lives in close association in or on another (the host), and derives benefits such as nutrition at the host's expense. Unlike predators and parasitoids, parasites do not usually kill their hosts, except when they occur in high numbers. In contrast, predators most certainly kill their prey, and parasitoids typically cause death in a host species by laying a single egg therein. Much like the creature in the film *Alien*, the egg hatches and the parasitoid feeds, grows, and emerges, ultimately killing the host.

Virtually every species is parasitized at some point during its lifetime. As an example, Shipley (1911, in Thompson 1927) described birds as "zoological gardens" of parasites. Indeed, broadly defined, parasitism may be the most common lifestyle among animals (Price 1980). A conservative estimate of the number of parasite species described to date worldwide is 600,000 (Toft 1991), or about one-third of all described species of plants, animals, and microorganisms. Approximately 1,200 species of parasites are known from marine and freshwater fishes in Canada alone (see Table 1), slightly more than the 1,150 fish species reported to date (Coad 1995), though only 36% of fish species have been examined for parasites to date.

Unique because of their habitats, ecologically important as population moderators, and interesting because of their intricate lifestyles, parasites form a varied and valuable segment of biodiversity. Some species are useful or have important potential as biological control agents, protecting crops, trees, domestic stock, or natural ecosystems worth millions or billions of dollars. Their conservation has been ignored, and although any effort to preserve hosts in natural environments may aid in preserving their parasites, some *ex situ* conservation projects rid hosts of parasites.

Canada has a rich history in parasitology, featuring many of the world's leading scientists. However, as in other areas of systematics, Canada's capacity to study parasites is diminishing because retiring scientists are not being replaced and systematics programs are not being offered in Canadian universities. As research emphasis shifts, the continuing cost of maintaining the collections of long-gone workers is difficult to justify. These collections may be transferred to other institutions, such as government-funded research facilities or museums, or they may simply be discarded. Even museums are finding collection maintenance increasingly onerous and decreasingly valued by their financial sponsors. Few Canadian museums keep specific parasite collections or have researchers in the field.

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Table 1. Numbers of parasite species by taxon found up to 1993 infecting freshwater and marine fishes in Canadian waters, obtained from Margolis and Arthur (1979) and McDonald and Margolis (1995) and to date, disproportionately more freshwater than marine fish hosts have been studied. Numbers of fish species examined represent only 36% of those found in Canada (McDonald and Margolis 1995). More parasite species, including those newly described, continue to be found on a regular basis.

	DULÇAQUICOLES	MARINS
Protozoa		
Mastigophora	14	5
Apicomplexa	35	22
Microspora	8	6
Ciliophora	23	13
Rhizopoda	1	0
Other	1	0
Myxosporea	113	59
Cnidaria	1	1
Turbellaria	0	1
Trematoda		
Aspidogastrea	1	1
Digenea	113	144
Monogenea	180	44
Cestoda	70	54
Nematoda	56	31
Acanthocephala	23	11
Annelida	19	14
Mollusca	7	0
Arthropoda		
Crustacea	35	130
Acarina	3	0
	703	536

CLASSIFICATION AND TAXONOMY

Parasites can be divided into microparasites and macroparasites. **Microparasites** include viruses, bacteria, fungi, and protozoans. Microparasites typically multiply and complete their life cycles, including development and reproduction, within only one host, though numerous protozoans have complex life cycles requiring more than one host.

Macroparasites, represented by many taxa, are larger multicellular organisms that usually possess complex life cycles involving one or more intermediate host and one final or definitive host. Growth and development occurs within the intermediate host, and sexual reproduction takes place within the definitive host. Complex life cycles among parasites are analogous to the metamorphosis of a caterpillar into a butterfly, except that the life cycles may be composed of both free-living and parasitic states, and often involve more than one larval stage.

- Macroparasites are represented by many taxa. The helminths (or worms) belonging to the classes Monogenea (ectoparasites), Trematoda (flukes), and Cestoda (tapeworms) — collectively known as flatworms, and the phylum Acanthocephala (thorny-headed worms) are exclusively parasitic. They infect vertebrates as adults, with a very few exceptions occurring in invertebrates, and all

"Canada has a rich history in parasitology, but its capacity to study parasites is diminishing."

but the monogenes have complex life cycles with one or more intermediate hosts. Morphologically they are extensively modified to live in or on another organism. Some even lack a digestive system and may simply be viewed as bags of gonads.

- The phylum Nematoda (round-worms) consists of both free-living and parasitic species. Life cycles may be direct or complex. Adult parasitic roundworms are associated with vertebrates, invertebrates, and plants.
- The phylum Arthropoda includes parasitic forms such as many copepods, isopods, mites, lice, and insects. Like parasitic nematodes, adult parasitic arthropods may be associated with invertebrates, vertebrates, or plants.
- Even parasitic plants are known to exist, from unicellular dinoflagellates parasitic on invertebrates and fish to vascular plants, such as mistletoe, infecting other plants.

COMPLEXITY OF LIFE CYCLES The type of life cycle varies among parasitic groups, with closely related groups displaying similar patterns. Each parasitic taxon is characterized by particular life cycle forms and patterns. Complex life cycles may consist of eggs, free-living infective stages, larval stages parasitic in intermediate hosts, and adult stages in definitive hosts. For example, examine the life cycle of the nematode known as the codworm or sealworm *(Pseudoterranova decipiens)* shown in Figure 1. Typical of all nematodes, *Pseudoterranova decipiens* has a life cycle consisting of five stages separated by four moults. Another example of a different life cycle is that of the fish tapeworm *(Diphyllobothrium latum),* which infects humans among other animals. The definitive host and intermediate hosts are shown in Figure 2. In this life cycle there are five morphologically distinct stages.

Other differences in the life cycles are reflected in the way parasites infect their hosts. Do they directly infect their hosts by penetration or by being ingested? Or are the parasites, such as those causing malaria and sleeping sickness, transmitted by vectors (blood-feeding animals such as mosquitoes and leeches)? In the case of macroparasites, many may be transmitted through predator-prey interactions, such as when a potential host feeds on an infected intermediate host. Different combinations of these routes of transmission can even occur within the same parasite life cycle. See Figure 3, for example, where *Diplostomum spathaceum,* the parasite that causes blindness in fish, uses two different methods to infect three different types of animals: snails and fish are infected by free-swimming infective stages, and gulls by the ingestion of infected fish.

When a parasite infects the wrong host, it often dies. But sometimes it can cause problems for that host, such as when some people who suffer from intestinal irritation or peritonitis are discovered to have acquired the nematode *Anisakis simplex* from raw seafood dishes such as sushi. Clearly parasitism reflects a diverse array of taxa, body forms, and life cycles.

DISTRIBUTION Each parasitic group possesses its own specialized and distinctive morphological, physiological, behavioural, and life-cycle adaptations. These adaptations permit the parasites not only to infect hosts and find their particular habitat in those hosts, but also to live and thrive in these living habitats once they get there.

Typically, most parasites are specific to their host species, or to a closely related group of hosts. The degree of specialization varies among parasites and with the stage in the life cycle. Some parasites are generalists, infecting a variety of similar species. For example, the sealworm *Pseudoterranova decipiens* has quite a broad distribution; it infects over 24 species of fish as intermediate hosts in Canada's Gulf of St. Lawrence alone (Marcogliese 1995; Boily and Marcogliese 1995) or 60 in the North Atlantic (McClelland et al 1990). Others, such as many monogeneans, will only occur in a particular host species. When such a host species becomes extinct, so will its host-specific parasites. Without a doubt, species driven to extinction have also been accompanied by their

A DIVERSITY

Figure 1

Life cycle of roundworm, the sealworm

Pseudoterranova decipiens

This life cycle of consists of an egg and five stages separated by four moults, the final stage being the adult.

A) The sealworm egg is passed into the water with seal faeces. The first moult to a second-stage larva occurs in the egg. The location of the second moult to the third-stage larva is contentious, and is currently debated by scientists.

B) In one to five days, depending on water temperature, a larva hatches and adheres to the bottom.

C) The larva is then eaten by a microcrustacean, such as the harpacticoid copepod shown here. These larvae conform morphologically to third-stage larvae.

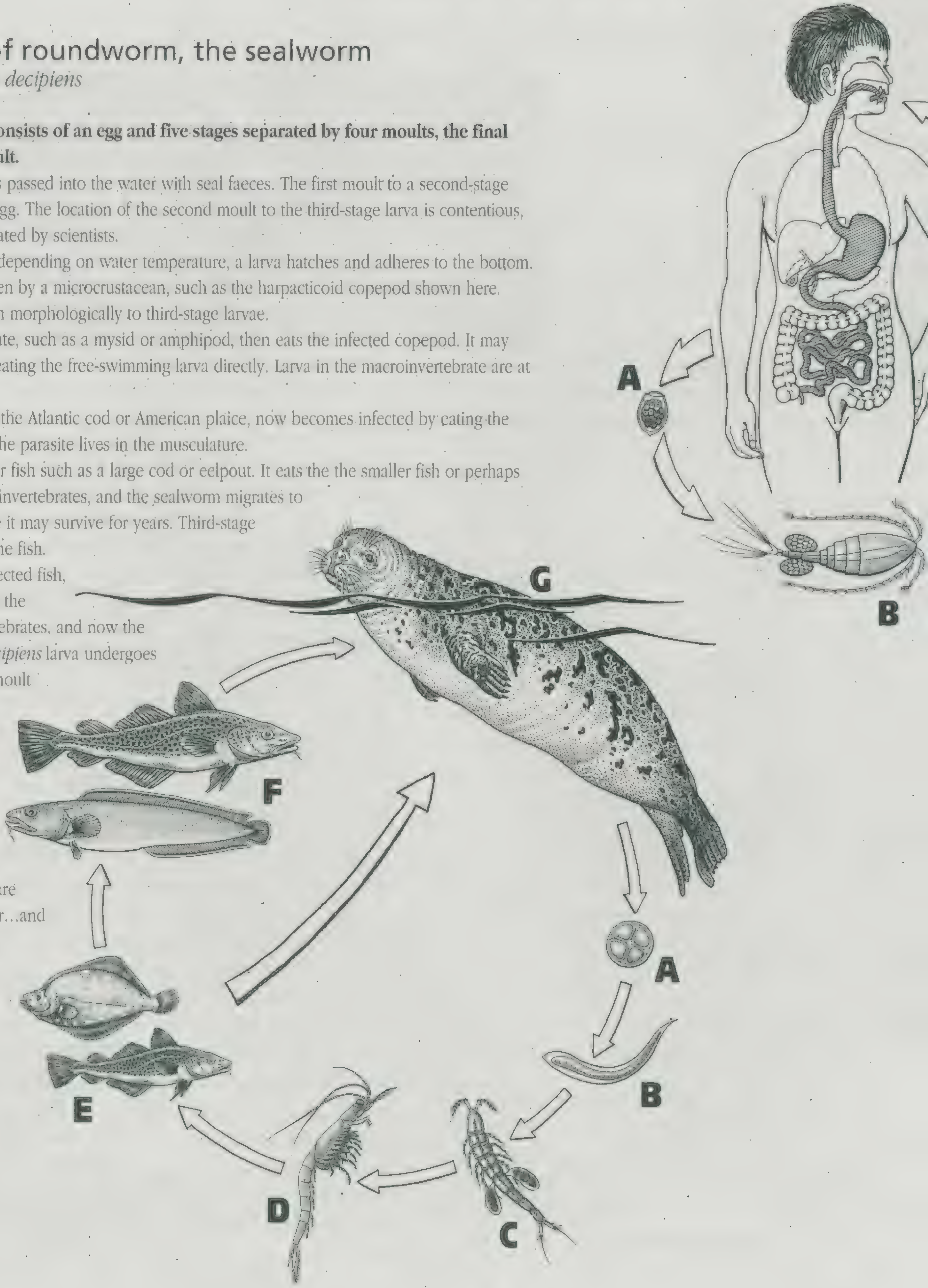
D) A macroinvertertebrate, such as a mysid or amphipod, then eats the infected copepod. It may also be infected by eating the free-swimming larva directly. Larva in the macroinvertebrate are at the third stage.

E) A small fish, such as the Atlantic cod or American plaice, now becomes infected by eating the macroinvertebrate. The parasite lives in the musculature.

F) Along comes a bigger fish such as a large cod or eelpout. It eats the the smaller fish or perhaps other infected macroinvertebrates, and the sealworm migrates to the fish's flesh where it may survive for years. Third-stage larvae are found in the fish.

G) The seal eats the infected fish, or it may (rarely) eat the infected macroinvertebrates, and now the *Pseudoterranova decipiens* larva undergoes its third and fourth moult to an adult in the seal's stomach. Sexes are separate in nematodes, and the adults must mate to reproduce. Eggs are released, which are passed into the water…and so on all over again.

(Based on McClelland et al 1990)



F LIFE CYCLES

Figure 2

Life cycle of a fish tapeworm
Diphyllobothrium latum

This life cycle is characterized by five morphologically distinct stages. Only the hosts are shown here.

An egg **(A)** is passed into water via the faeces of the definitive host; the egg hatches and a free-swimming spherical, ciliated coradium hatches. This larval stage is ingested by a copepod **(B)**, the parasite develops into a procercoid in the body cavity of the copepod. The infected copepod is eaten by a fish **(C)**, such as a pike or perch. In the fish the parasite, which has developed into a plerocercoid, is found in the musculature. The final host is a carnivore, such as a bear or human, which acquires the parasite by eating the infected fish. The parasite develops into an adult tapeworm in the intestine, and reproduces. Each segment in an adult tapeworm contains both male and female reproductive organs.

(Based on Noble and Noble 1973)

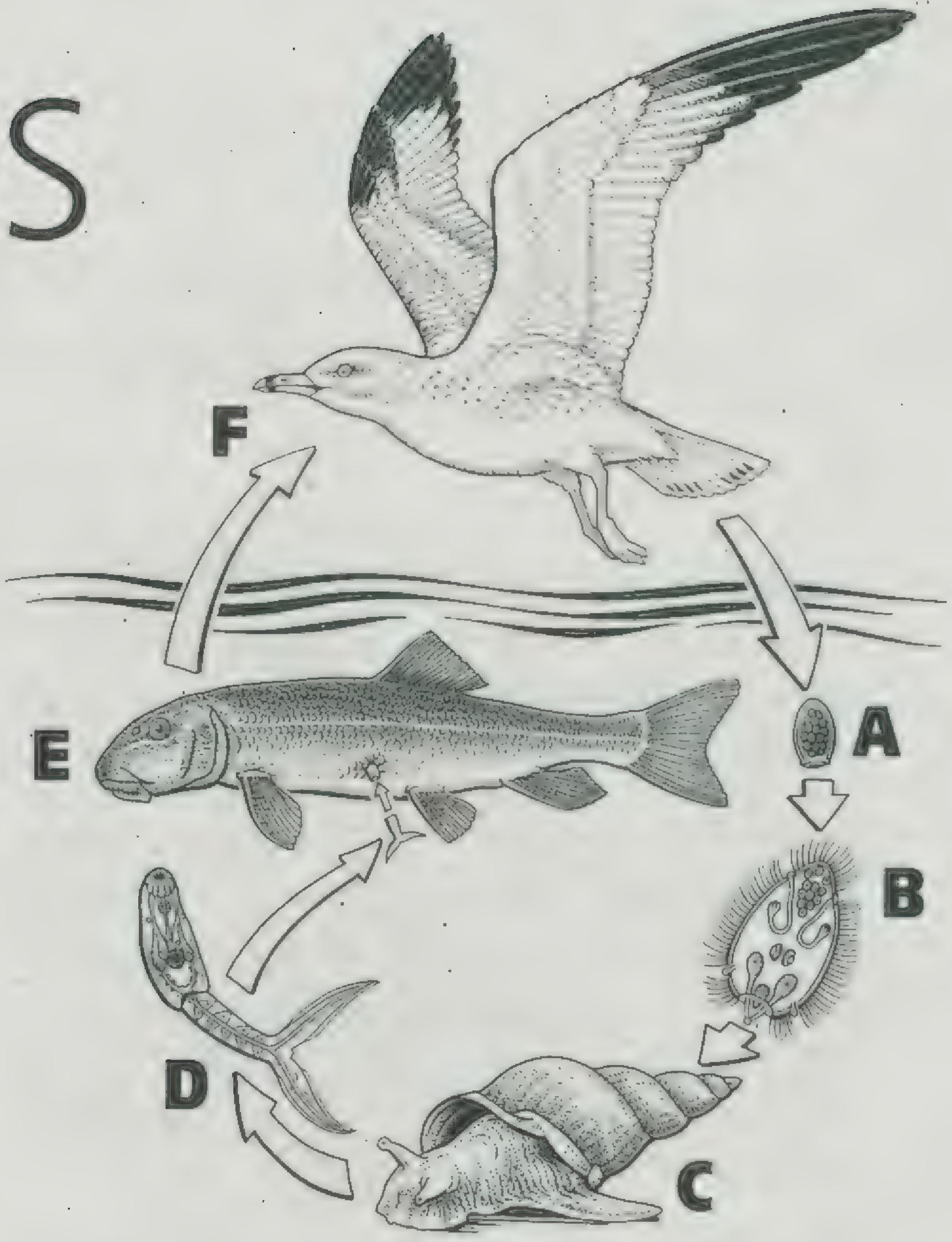


Figure 3

Life cycle of a flatworm, the eye-fluke
Diplostomum spathaceum

This life cycle is characterized by two free-swimming stages that actively penetrate their hosts, followed by an infective stage in the eye of a fish. For the life cycle to be completed, the fish (intermediate host) must be eaten by the appropriate bird (definitive host).

A) The egg is passed into the water with bird faeces.
B) A free-swimming miracidium or ciliated larva hatches. This stage typically is very short-lived (one to two days).
C) The miracidium penetrates the body surface of a snail of the Family Lymnaeidae. Within the snail, *Diplostomum spathaceum* undergoes a complex series of developmental changes and asexual reproduction, or cloning. First a mother sporocyst (the first asexual reproductive body of *Diplostomum spathaceum*) is formed. The mother produces many daughter sporocysts, which in turn produce many cercariae.
D) The free-swimming, fork-tailed ceracariae leave the snail host into the water. This stage lives one to four days, depending on the temperature.
E) The ceracaria penetrates fish skin or gills and then migrates to the eye. In the eye, it develops into a metacercaria, where it can survive for a few years.
F) At this point, a bird (usually a gull) eats the infected fish. *Diplostomum spathaceum* now develops into an adult in the gull's intestine, and reproduces. Adults are hermaphroditic; that is, they possess both male and female reproductive systems.

(Based on Ginetsinskaya 1970)

> "By regulating the number of dominant species, parasites contribute to the diversity of other species."

endemic parasites. In contrast, when a species is introduced into a new habitat, there is a risk that it brings with it new parasites that will be harmful to the native fauna and flora.

Distribution and abundance of parasites vary among species and hosts. There are no set rules determining whether parasites are common or rare. Numbers of parasites and their distribution depend on ecological conditions, the availability of hosts, and host density. Generally, the biogeographic distribution of a parasite reflects that of its host(s).

ECOLOGICAL ROLE Parasites can actually regulate the abundance of their hosts (Anderson and May 1979; May and Anderson 1979). This is a result of parasite-induced host mortality, where heavily infected hosts die off. In addition, parasites are known to influence the behaviour of intermediate hosts, making them more susceptible to predation, thereby facilitating transmission to the next host in the life cycle (Holmes and Bethel 1972; Moore 1984). They also may make hosts less resistant to disease, starvation, pollution, and other environmental stresses.

Because parasites can regulate host populations, they may be able to influence community structure through the control of key species (Minchella and Scott 1991). Thus, even though parasites do not directly participate in the food chain in the traditional sense, they can have profound effects on community structure, trophic interactions, and food webs through parasite-mediated behaviour and host mortality.

Perhaps one of their most important roles is to control population outbreaks or explosions. Dense host populations can lead to increased rates of parasite transmission and the spread of disease. By regulating the number of dominant species, parasites contribute to the diversity of other species as well as constituting part of biodiversity themselves.

Parasites form communities, and in certain ways, the organization of parasite communities is similar to those consisting of free-living organisms. For example, within the intestine of a host, parasites that are competing for nutrients and/or space may partition the resources among species. Different species of nematodes in the intestine of the European tortoise *(Testudo graeca)* partition the intestine both longitudinally and radially. Those that do overlap spatially ingest different food items (Schad 1963). With few exceptions, one fundamental difference between the communities of parasites and free-living organisms is that parasites do not act as direct predators on other organisms, nor are they directly preyed on.

USEFUL AS BIOLOGICAL INDICATORS Parasites are indicative of many aspects of the biology of their hosts, including diet, migration, recruitment, population distinctness, and phylogeny (Williams et al. 1992). They also may be good indicators of environmental contaminants and stress (Sures et al 1994; MacKenzie et al 1995; Marcogliese and Cone 1996). For example, parasite species-richness in eels in Nova Scotia decreased in acidified rivers (Marcogliese and Cone 1996). Because parasites have a variety of intermediate hosts, many of which depend on trophic interactions for transmission, parasites within a vertebrate host may be excellent indicators of food web structure and biodiversity (Gardner and Campbell 1992; Marcogliese and Cone, 1996, Marcogliese and Cone 1997).

CASE STUDY: THE ST. LAWRENCE SYSTEM Parasites are common in all ecozones throughout the St. Lawrence watershed, including the river and gulf. While only limited data exist in terms of parasite surveys and inventories, some good representative surveys of parasites can be found (excluding viruses and bacteria). In the fluvial zone of the St. Lawrence River, the freshwater fish muskellunge *(Esox masquinongy)* is infected with 8 helminth species (Choquette 1952). A total of 55 parasite taxa (both microparasites and macroparasites) were found among four species of

> "Environmental organizations are as guilty as governments, zoological gardens, and others in ignoring parasite conservation."

marine fish, the Greenland halibut *(Reinhardtius hippoglossoides)*, capelin *(Mallotus villosus)*, and two species of redfish *(Sebastes fasciatus* and *Sebastes mentella)* (Arthur and Albert 1994; Arthur et al 1995; Moran et al 1996). Beluga whales *(Delphinapterus leucas)* are infected with at least 11 helminth species in the saltwater estuary (Measures et al 1995). While no complete surveys exist for other vertebrates in the region, it is generally acknowledged that birds and terrestrial mammals harbour a much more diverse parasite fauna than do freshwater fish (Kennedy et al 1986). Diversity of parasites in marine fishes tends to approach that in birds and mammals (Holmes 1990).

Probably many parasites have been in the St. Lawrence system and surrounding areas since the last glaciation, having colonized with their hosts. Others were likely subsequent introductions along with new hosts or climatic change. We can expect to see alterations in the distribution, abundance, and species composition of parasites with changing environmental conditions (Dobson and Carper 1992). For example, global climate change may lead to the spread of parasites from warmer southern areas into the St. Lawrence basin. Recent changes in the abundance of nematodes attributed to water temperature have been observed in both cod and seals in the Gulf of St. Lawrence (Boily and Marcogliese 1995; Marcogliese et al 1996). Given that parasites can regulate the abundance of their hosts and influence community composition, it follows that changes in parasite distribution, abundance, and species composition may have an impact on agriculture, forestry, fisheries, and free-living organisms (including rare and endangered species) in the St. Lawrence basin and elsewhere.

CONSERVATION OF PARASITES The need to conserve all species, or as many as possible, of the planet's biodiversity is commonly accepted. When it comes down to practice however, larger, "beautiful," economically useful, terrestrial organisms are given higher priority than smaller, "ugly," non-cuddly, unexploited, or aquatic organisms. Environmental organizations are as guilty as governments, zoological gardens, and other organizations in ignoring parasite conservation. Wilson (1984) elaborated on the chain of cataclysmic events following the loss of a species, including the extinction of its parasites, and Sprent (1992) lamented the probable loss of parasite species because of the increasing rarity of their hosts resulting from destructive human activities. Although local parasite populations may become extinct with the fragmentation of host populations, parasite extinctions at a larger scale probably require complete host extinction (Bush and Kennedy 1994).

Parasites should be considered in any conservation program. Dense host populations, which can result from conservation programs and habitat fragmentation, lead to increased disease transmission, reduced nutritional status, and increased stress, all of which act synergistically (Scott 1988). (Similar effects can be expected when livestock, domestic fowl, and aquacultural fishes are kept at high density.) With increasing habitat fragmentation, opportunities for parasites to become pathogenic increase as a result of environmental stresses acting on hosts' immune systems, reduced adaptability of hosts, and potential invasions of new parasites (Holmes 1996). Yet, protection or isolation from parasites can lead to reduced genetic diversity and increased susceptibility to disease (Scott 1988).

The contribution of parasites to the planet's biodiversity has not gone completely unnoticed (Wilson 1992), and on those grounds alone they deserve preservation. The International Convention on Biological Diversity recognizes the intrinsic right of species to exist. Certainly parasites should be preserved because of their ecological function regardless of human biases. Parasites are indicative of many aspects of the biology of their hosts and their environment, and are influential in maintaining the genetic diversity of their hosts. Their role as potential agents of disease cannot be ignored.

Parasites act as a double-edged sword. They can be beneficial to humans as well as to populations and communities of organisms or detrimental to the same groups. For these reasons parasites should be considered more thoroughly in conservation programs, wildlife management, habitat preservation and modification, and in ecological studies of animal and plant populations and food webs. Parasitism is simply a reflection of the natural state of ecosystems, and healthy populations of organisms will play host to healthy populations of parasites.

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"Parasites should be preserved because of their ecological function regardless of human biases."

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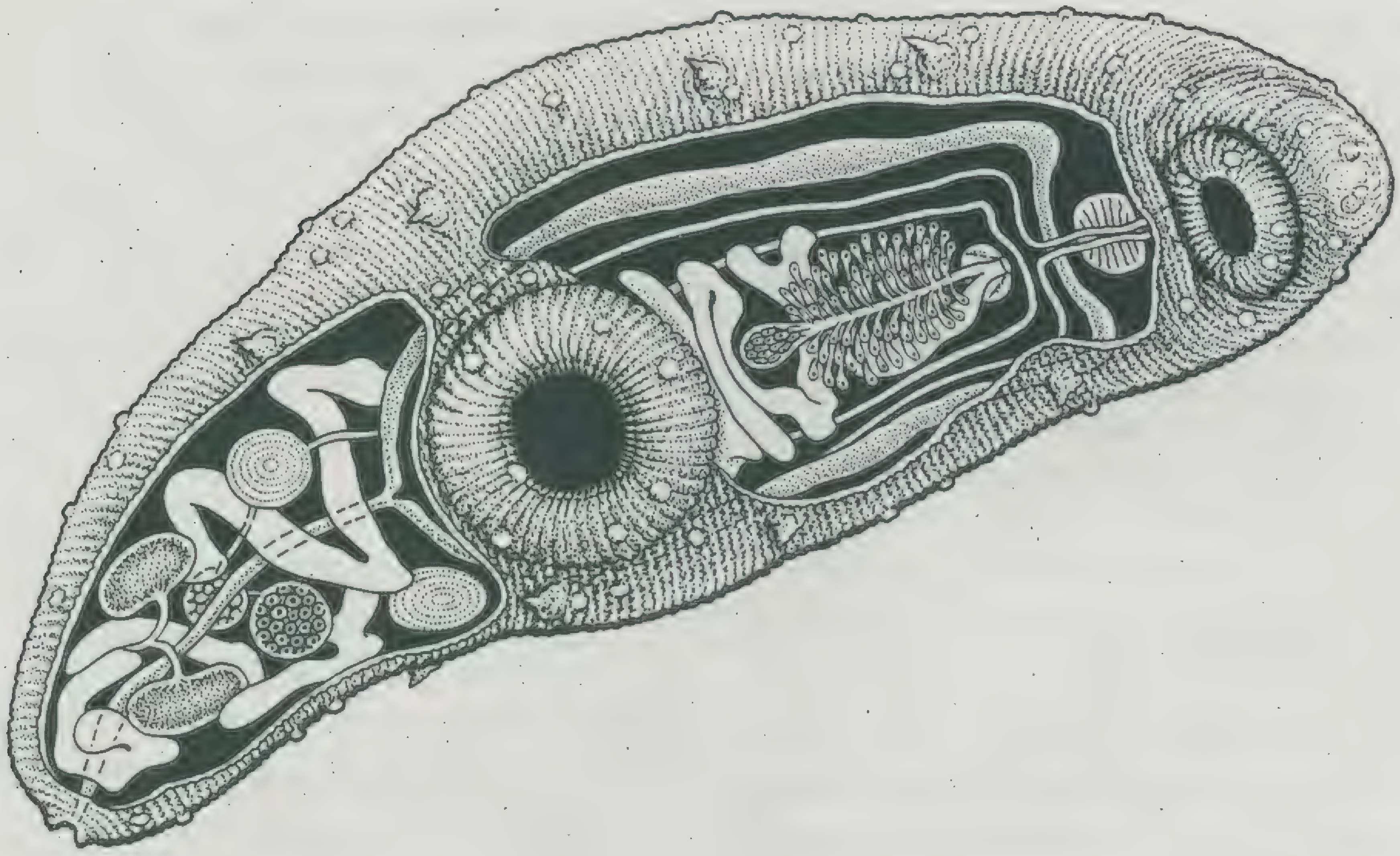
Marine trematode

Derogenes varicus



The marine trematode *Derogenes varicus* is perhaps the most widely distributed animal in the world. This trematode is found in the stomachs of over 100 species of marine fish across temperate and sub-polar oceans and seas in both the northern and southern hemispheres. In addition it is found within species of the deep cold waters of warmer latitudes. Dr. Harold Manter of the University of Nebraska was the first to note this unusual distribution. He concluded that the present distribution resulted from the arrangement of cold water masses and deep ocean currents, which may exist now or did exist at some point in the geological past.

There are about 20 species of trematodes with bipolar distributions, though none as widely dispersed among different fish species as *Derogenes varicus*. Manter used the distributions of marine fish parasites to infer current and ancient connections between remote areas of the globe, and was one of the first scientists to provide biological evidence in support of plate tectonics.

The life cycle of *Derogenes varicus* is quite complex, involving a snail (the Natica species, for example, in the North Atlantic) as the first intermediate host, followed by a crustacean (usually a copepod, but occasionally a hermit crab) as the second intermediate host, an arrow worm (chaetognath) as an optional intermediate host, and a fish as the definitive host. The adult parasite is shown here.
[David J. Marcogliese and Judith Price]

Assessing insect biodiversity — without wasting your time

The sheer numbers of insect species make them important indicators of ecosystem health, but very difficult to study.

by H.V. Danks

Initial sort, to major groups, of a bulk collection.
(Photo courtesy of Agriculture and Agri-Food Canada)

Although most groups of insects are incompletely known, they are extremely diverse and important to ecosystems (Wiggins 1983). Their pervasive ecological importance makes them valuable when assessing disturbance or environmental impacts of various kinds (Lehmkuhl et al 1984; Rosenberg et al 1986). A focus only on large and conspicuous organisms misrepresents ecosystem structure and dynamics (Kremen et al 1993). Understanding arthropods therefore is essential to conserve or manage ecosystems properly. However, work on insect biodiversity is difficult due to our incomplete knowledge and limited resources. Therefore, careful targeting of any study is essential, and this article presents a series of 14 components in planning and conducting an effective study of insect biodiversity (Danks 1996).

STEP 1: DEFINING VALID OBJECTIVES Studies of biodiversity should attempt to answer specific questions, not simply generate isolated lists of species. For example, what is the impact of changes such as artificial disturbance or pollution on ecosystem function or persistence, as estimated by the diversity of certain trophic groups? In addition to specific objectives, biodiversity studies can also serve to establish a long-term baseline for assessing differences between one place and another, from the present to the future, and under different conditions.

STEP 2: GATHERING EXISTING INFORMATION Knowing what information is already available allows you to identify what is missing, and thus design studies targeted at discovering new and specific useful information (Rosenberg et al 1979). It may be useful to compare and verify a project with previous studies. Provided that the earlier work was carried out adequately, it may be more cost effective to use the associated relevant information or previously collected specimens than to repeat a full sampling program.

STEP 3: DEVELOPING A PLAN FOR THE PROJECT AS A WHOLE The key to an effective overall plan is to allocate sufficient funds and personnel for each stage of the study over a time frame that is of adequate duration. Otherwise, there is the risk that you will expend most of the resources on collecting and preparing specimens before you even reach the identification, curation, and publication phases of the study. Moreover, establishing specific procedures early in the project also ensures that all species of interest will be sampled reliably. Conversely, "generalist" assessments of the biodiversity of an area often miss species. The resulting incomplete findings waste time and resources.

To ensure adequate sampling, invite both taxonomists and ecologists to participate in the design or review of general plans for sampling biodiversity early in the project development. It is essential to enlist the cooperation of

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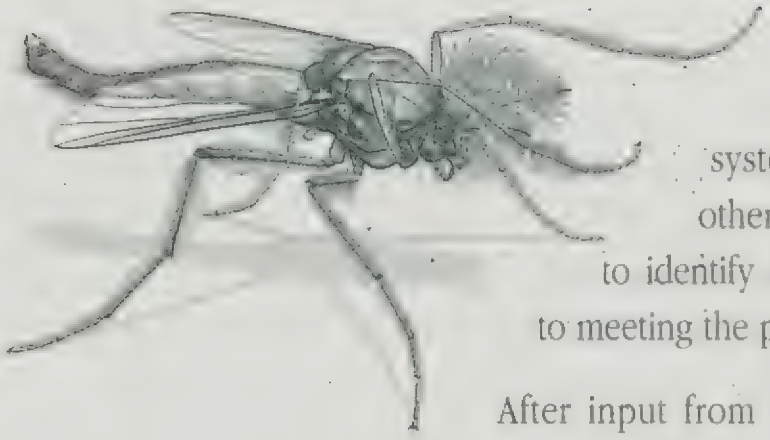
"Securing reliable identification to species is the single greatest difficulty in work on insect biodiversity."



systematics experts at the start; otherwise, it may not be feasible to identify the groups that hold the key to meeting the project objectives.

After input from the experts, re-examine the need for resources for all elements of the project. For example, will you have to purchase expertise to identify key target groups and to solve taxonomic problems that may be encountered? In many cases, the necessary expertise will not even be *available* for outside purchase, and will have to be staffed and developed from the beginning as part of the project. The costs of obtaining and preparing samples can also be very high (e.g. Scudder 1996).

By developing a detailed, adequately funded plan for the project as a whole, you will ensure scientifically valid results — results that not only address the project objective but provide baselines for future work (Lehmkuhl et al 1984).

STEP 4: IDENTIFYING TO THE SPECIES LEVEL For nearly all objectives, it is better to have species-level information on a few carefully chosen groups than family-level information on many. Species-level information is valuable for two main reasons. First, species are the functioning entities in nature. Through species-level identification, a good understanding of ecosystem interactions becomes possible. Also, each species has a different tolerance for conditions (e.g. Resh 1976; Resh and Unzicker 1975). Grouping species in the same insect family is not usually appropriate. Indeed, a family of insects such as chironomid midges contains species differing greatly in relative size and feeding habits — a diversity similar to that of the whole of the birds. The first reason for specific identifications, therefore, is biological reality and applicability of data.

A second reason for species-level work is that information can be stored under species names, which permits the knowledge to be referenced effectively (Danks 1988) and to be re-used and integrated through time. Identifications only at higher taxonomic levels do not uniquely document diversity or make it possible to use the information for detailed comparisons.

STEP 5: SELECTING SUITABLE SAMPLING SITES Generally, it is better to choose sites that are accessible, discrete and easily recognized, and stable over the long-term (Danks et al 1987). At a more specific level, site choice depends on the objectives of the study, because few studies of biodiversity have sufficient resources to complete a full regional inventory of species from all habitats in a range of places. If the initial project focus is on habitat (e.g. forest types), sites should be fully representative of each habitat type of interest. If the primary focus is on taxa with particular ecological properties of interest (e.g. herb-feeding bugs), emphasizing habitats favoured by these organisms, as determined by expert advice, increases the efficiency of sampling.

STEP 6: SELECTING THE GROUPS FOR STUDY Ideally, a relevant but taxonomically and ecologically diverse set of species, related to the project objectives, should be collected and studied. Predators and herbivores, for example, would be expected to show different patterns and to provide different insights. However, restricting studies to only one or two easy-to-identify groups ignores many other potentially instructive taxa, and relatively little use is then made of costly samples.

You cannot collect and study every species, however, and any choice is a compromise between scientific relevance and feasibility. Here are some questions to ask: How will the size, habits or habitat of the groups affect the ease of sampling and sorting? Are the groups well known enough to allow specific identifications? Are experts available even for well known groups? Are you emphasizing "feasibility" to the extent that your sampling is confined to taxonomic groups that provide little useful information about the objective?

> "It is not practical to collect and study every species and any choice is a compromise between scientific relevance and feasibility."

Consider a study that characterizes forest types, ages, or treatments by means of taxa that are relatively easy to identify, but that occur almost exclusively in large clearings or in pools. Because the taxa found in large clearings, and those in pools, tend to be similar in the different types of forests, the study is unlikely to provide valuable scientific information.

Conversely, a study with the objective of ascertaining what changes in biodiversity occur in grazed meadows compared to ungrazed sites, and how these changes can be minimized, might target feasible groups (i.e. those that can be sampled and identified) expected to signify the relevant changes. These changes might include the occurrence and vigour of specific plants and allied microhabitats (reflected by selected plant bugs, for example) or ground exposure (reflected by grasshoppers, which deposit their eggs in bare soil, and by soil mites that respond to local soil moisture and other soil factors). Changes in such species would also indicate if important links with other organisms are likely to be disturbed, and suggest further consequences. An informed biodiversity study of this sort can suggest whether and how mitigation is to be carried out.

STEP 7: DURATION OF THE STUDY It is not usually possible to sample insect diversity adequately over a short time frame. In particular (given natural variation and insect life cycles), short visits to sites typically provide only a small random selection of the real diversity, yet local diversity cannot be characterized unless the core data sets are more-or-less complete.

STEP 8: SELECTING AND STANDARDIZING SAMPLING METHODS Sampling methods should be multiple, targeted, cost-effective, and standardized. By standardizing methods, information from different sites, regions, and times can be compared effectively. (For details, see Marshall et al 1994.) The most cost-effective sampling methods are passive or behavioural, in which insects come to the trap or collecting vessel rather than being pursued by the collector. Such techniques yield huge numbers of specimens and lead to good habitat coverage, but they create difficulties of sorting and selection.

Taking replicate samples is also important. Replication allows one to make a key assessment: Are the differences in biodiversity between different places or different times real, or do they simply reflect sampling variation? The need for replication is often overlooked because of the high cost of handling material from multiple traps or sites.

STEP 9: ENSURING QUALITY IN SAMPLING To reduce errors in siting traps and sampling, technical staff must implement the selected techniques in a careful and standardized manner. Adequate training is vital — before the project begins.

STEP 10: SORTING AND PREPARING SAMPLES Sorting and preparing samples captured by insect traps is extremely time consuming, taking up to 40 times as long as sampling (Marshall et al 1994). Strict control and standardization ensures the integrity of data and the long-term preservation of specimens. Establishing laboratory protocols (such as dealing with only one trap sample at a time) will help to avoid cross-contamination of samples or mislabelling of specimens.

It is particularly important to plan sorting and preparation with identification in mind. If carelessly or incorrectly prepared, specimens of many groups are much more difficult or impossible to identify. To avoid this difficulty, obtain detailed instructions about preparation from the cooperating systematists as the project is being developed.

STEP 11: TRANSFERRING MATERIAL TO EXPERTS FOR IDENTIFICATION Unfortunately, there is no "black box" into which specimens can be fed for identification, and securing reliable identification to species is the single greatest difficulty in work on insect biodiversity. Despite the increased interest in biodiversity in recent years, the number of professional systematists has continued to decline (e.g. Kosztarab and Schaefer 1990), and the

“Insects are extremely diverse and important to ecosystems.”

resources to provide identifications cannot be taken for granted. In short, taxonomic expertise is at a premium and as stated earlier, it is essential to secure the advice and cooperation of a good taxonomist early in the planning process. Early involvement by a taxonomist also means that sampling, sorting, and preparation methods can be performed to meet his or her standards. To cement a cooperative relationship, allow specialists to retain specimens of particular interest for their own research and acknowledge their help appropriately (e.g. in published citations).

STEP 12: DATA MANAGEMENT Studies of biodiversity generate extensive data and require efficient means of managing and reporting information. When the framework for data management is designed during the planning stages, a system can be put into place before any data are collected. As long as the data are properly recorded in a logical manner, you can minimize subsequent inefficient transcription or splitting of data fields for analysis and exchange information with other databases.

STEP 13: RETAINING VOUCHER SPECIMENS Plan to retain the voucher specimens (actual specimens documenting the taxa recorded) so that you can validate the specific entities from the study and allow both future checking of data and further use. These specimens are very important for evaluating changes or impacts (e.g. Resh and Unzicker 1975; Wiggins et al 1991). Also, advances in taxonomy, or errors in original identifications, may require re-examination of the material.

Often vouchers are best kept associated with the original sites or habitats rather than being dispersed in a taxonomically arranged collection (Danks 1991). This requirement reinforces the need for a long-term plan for the execution and funding of such later aspects of the study.

> "To use time and resources wisely, it is essential to start with a long-term overview of the requirements for the whole project."

STEP 14: SHARING THE RESULTS The goal for any well-planned project is valid, organized, and accessible information. I recommend publishing the results, based on the carefully validated specific identifications, in appropriate journals. You might also use the Internet as a means of dissemination. However, any identifications or conclusions that have not been fully evaluated by qualified experts or peer review and publication should be clearly marked as interim.

CONCLUSIONS To use time and resources wisely, any project on insect biodiversity needs clear objectives that proscribe taxonomic and habitat limits. It is essential to start with a long-term overview of requirements for the whole project, including all stages, from initial planning and wide consultation with a variety of experts, to the analysis of data, disposition of specimens, and publication of results. Because the value of the data depends on reliable identification to species, and because taxonomists are in short supply and high demand, acquiring taxonomic expertise is the single greatest challenge for biodiversity studies. Such expertise should be funded as an explicit and integral component of the project.

In the longer term, the need for taxonomic expertise also requires planning at a level above that of individual projects — it requires government support, university training, and other infrastructures for systematics.

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Dr. Danks' article is an abridged version of a brief produced for the Biological Survey of Canada (Terrestrial Arthropods). Copies of the full brief are available in limited numbers from the Survey at the address on page 17.

More information about the Biological Survey of Canada is available at <http://www.biology.ualberta.ca/esc.hp/bschome.htm>.

Beetle: Courtesy Agriculture and Agri-Food Canada, *Beetles Associated with Stored Products in Canada: An Identification Guide.* Reprinted with the permission of the Minister of Public Works and Government Services Canada, 1997.

Fly: Courtesy Agriculture and Agri-Food Canada, *Manual of Nearctic Diptera,* Volume 1. Reprinted with the permission of the Minister of Public Works and Government Services Canada, 1997.

We care about forest biodiversity

A response to Jeffrey A. McNeely's article published in Global biodiversity *6(2), submitted by Simon Nadeau and Jean-Pierre Martel, Canadian Pulp and Paper Association. Dr. McNeely's paper is available at <http://www.nature.ca/english/mcneely.htm>.*

In the Fall 1996 issue of *Global biodiversity*, Jeffrey A. McNeely of the World Conservation Union (IUCN) argues that forest stakeholders have many different interests regarding the forest resource (McNeely 1996). Forestry companies want timber, pharmaceutical firms want sources of medicine, scientists want to do research, and students want to study ecology. McNeely lists no less than ten ministries of a hypothetical government with varying mandates related to the forest. As if to ask who's minding the store with all these customers scurrying through, the headline of McNeely's article reads: *Who cares about forest biodiversity?* The answer seems to be that we all care, in different ways, as we all benefit from the forest differently. But no one group, organization, or government department has forest biodiversity conservation as its sole mandate. Nor can one organization do the job. Rather, the collective integrated actions of many are required.

Canada's forest industry supports this ambitious objective, and is working towards a balanced, sound, and scientific approach to biodiversity conservation.

To sustain the world's forests and to satisfy the many human needs dependent on the forest, McNeely proposes four approaches to forest management for the 21st century, which in combination would prove appropriate for accommodating the various forest values. But along the way, his article misrepresents the economic and social benefits of the forest industry.

APPROACHES TO FOREST MANAGEMENT In 1992, participants of the Earth Summit in Rio de Janeiro, Brazil acknowledged that human survival is dependent on conserving nature, harvesting its fruits wisely, and sharing its benefits fairly and equitably. The task of convincing representatives from nations around the world to commit themselves to broad, collectively defined objectives for biodiversity conservation and sustainable use seemed immense, yet was achieved, and resulted in the Convention on Biological Diversity (CBD). At the local level, where on-the-ground action occurs, implementing conservation measures is even more difficult. McNeely's paper lists a combination of four management approaches that all nations might consider as a template, or benchmark, for forest management, and which adapts well to the approach already underway in Canada's forests:

- protected areas;
- multiple-use forests managed locally;
- natural forests managed primarily for timber production; and
- forest plantations.

Striking a proper balance between these four approaches is a sound objective in pursuing sustainable forest management, and is best defined through a consultative process with involvement from many sectors, such as government, local communities, citizens, NGOs, industry, and academics.

THE CANADIAN EXPERIENCE In recent years, Canada has taken a progressive step towards a definition of sustainable forest management that incorporates many forest values. In 1995, the Canadian Council of Forest Ministers (CCFM) developed criteria and indicators that define sustainable forest management in the Canadian context (CCFM 1995). The six general criteria are:

- conservation of biological diversity;
- maintenance and enhancement of forest ecosystem conditions and productivity;

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- conservation of soil and water resources;
- forest ecosystem contributions to global ecological cycles;
- multiple benefits to society; and
- accepting society's responsibility for sustainable development.

At the same time, another effort by another group was underway. This effort began in 1994 when a committee of the Canadian Standards Association initiated the development of standards for sustainable forest management systems. The committee consisted of government representatives, university researchers, research institutions, environmental non-governmental organizations (ENGOs), unions and consumer associations, wood product companies, industrial forest managers, woodlot owners, professional auditors, and many observers. The committee's work was supported by the forest industry. After the standards had been reviewed by ENGOs and the Canadian public, and had been field tested at six forest sites across Canada, they were approved by the Standards Council of Canada in 1996 (Canadian Standards Association 1996a, 1996b).

The standards are to be applied to a defined forest area on a voluntary basis, and incorporate all sustainable forest management criteria approved by the CCFM. For a "defined forest area" to be registered under these standards, the applicant must:

- demonstrate a commitment to establishing a sustainable forest management system;
- establish a public consultation process;
- develop, through the public consultation process, forest management objectives based on the CCFM criteria for sustainable forest management and local forest conditions and community values;
- incorporate these objectives into the forest management plan;
- select performance indicators for auditing performance towards each objective; and
- establish a system that will assist in maintaining and improving the forest management system over time as well as improving on-the-ground performance.

If the audit is not passed, the operation cannot be certified. The areas of failure are identified, but their impact on the final decision is not rated.

"Forests in Canada are dynamic and have the ability to recover from severe disturbances providing the recovery mechanism has not been affected by the disturbance."
(Photo by Don E. McAllister)

The standards are compatible with ISO 14001 and 14004 environmental management system standards. The standards stipulate clearly that biological diversity has been successfully conserved on ecosystem, species, and genetic levels when:

- varieties and types of communities and ecosystems are maintained through time on a landscape basis;
- all species originally present within an area thrive within that area; and
- the gene pool is maintained.

An important characteristic of the standards is the requirement for third-party audits to verify that operations in a given area comply with all relevant laws and regulations and the company's own sustainable forest management system. The standards also require annual reporting to the public on activities and audit results.

For those companies that wish to test the biodiversity aspects of forest operations before going through a standards audit, Wildlife Habitat Canada (WHC) has developed a biodiversity program in partnership with the forest industry. WHC is a national, non-profit foundation that has been working since 1984 with private citizens, governments, NGOs, and industry to protect, enhance, and restore wildlife habitat across Canada. WHC's Forest Biodiversity Program helps companies assess their capacity to manage for biodiversity, identify gaps, and develop strategies, goals, and objectives to properly address biodiversity conservation at all levels. This includes making sure that there is a commitment at the corporate level through policies and appropriate staff education and training, that goals are defined and objectives are met, and that monitoring is undertaken in order to continuously improve on-the-ground forest management activities.

THE ROLE OF THE FOREST INDUSTRY Canada's forest industry is an active participant in Canada's efforts to achieve sustainable forest management and biodiversity conservation. Companies are studying forest ecological functions and the requirements of key species, preparing management plans that preserve wild species and habitat, training staff in sustainable practices, managing the forest to ensure adequate forest regeneration, and conducting public awareness programs.

The Canadian Pulp and Paper Association (CPPA) was involved in negotiations leading up to the Earth Summit, and participated in all meetings of the Conference of the Parties to the CBD. On behalf of the forest industry, and in support of the Canadian National Forest Strategy and the Canadian Biodiversity Strategy, the CPPA established its own Forest Biodiversity Program. The program aims to help companies conserve biological diversity while achieving sustainable forest management. Through the program, Canadian forestry companies assist in the development of national policies, regulations, and legislation related to biodiversity conservation, and establish partnerships with groups such as Partners in Flight – Canada, which oversees the implementation of the Canadian Landbird Conservation Strategy. The program also helps companies learn about new developments and technologies, and benefit from each other's experiences and expertise in forest management.

DISTORTING THE FOREST'S VALUES In his article, McNeely also focuses on the conservation of diverse forest values. But the article distorts the relative importance of these values in its portrayal of the economic and social benefits of the forest industry. In Table 3 (p. 19), which measures the value of forests to various sectors of society, McNeely plots timber as important to timber firms and nearby communities, yet provides no specific category to indicate its importance as a source of local employment and wealth. Certainly, employment is a key factor in the well-being of individuals and communities. According to the Food and Agriculture Organisation of the UN, the forest sector provides subsistence and wage employment equivalent to 60 million work-years worldwide, 80% of which is in developing countries (Natural Resources Canada 1996). Note that the "forest sector" is broader than the forest industry. For example it includes the hunting and gathering activities upon which many local economies depend.

In Canada alone, at least 330 communities owe their existence to wood harvesting (Natural Resources Canada 1996), and the forest sector supports 988,000 jobs (Price Waterhouse 1995). In 1995, the forest industry contributed $34 billion to Canada's balance of trade, more than any other industry, and $5.1 billion in direct payments to governments through stumpage fees, taxes, and other contributions (Price Waterhouse 1995). The effects of these contributions ripple through society in an array of other, if perhaps less visible, economic and social benefits.

McNeely also portrays forest harvesting against the variety of other uses for forests in a polarized way, which again distorts the value of forests, especially in the Canadian context. Published alongside McNeely's article is a drawing of a chain saw over a tree stump (p. 17), accompanied by a caption stating that it takes 800 seconds to cut a tree to provide fibre for "lumber and paper" but 800 years to grow to the width shown in the image and provide a "clean water supply; moderate climate; ecotourism; medicines; ecological services; and beauty." What the caption ignores here, once more, is the fact that forest harvesting provides substantial employment. It also betrays a rather obvious ignorance of ecological processes; for trees provide all these uses listed above (clean water, etc.) well before reaching 800 years. Trees of this age are by far the exception in Canada, where much of the forest in the north is killed by wildfires every 60 to 120 years (Kimmins 1992). By implication, the image implies that the second-growth forests that result from forest harvesting are of lower quality for biodiversity. This suggestion is questionable in the boreal forest, where important natural disturbances have periodically rejuvenated the forests.

Recognition of the importance of forest disturbances has been a long-fought battle. One example concerns the deliberate suppression of forest fires in Mariposa Grove in Yosemite National Park in California, US, home of the giant sequoias, until the mid-1900s because people felt that by removing disturbances from the system, the sequoias would continue to exist forever. Scientists then

"In a forest stand consisting of conifers of the same age, the best harvesting technique from a practical and a 'natural' point of view might well be clear-cutting."
(Photo by Don E. McAllister)

"Participants in forestry debates must avoid simplifying forestry techniques into good-and-bad polarities."

realized that fire was necessary for sequoias to regenerate and to prevent the build-up of shade-tolerant white fir. Fire management has since been adapted to these new findings (Botkin 1990).

Another table in McNeely's paper (Table 1; p. 16) measures the compatibility of several forest uses with other needs. Here again, where forestry harvesting techniques are mentioned, the table becomes misleading. It pits clear-cutting as simply incompatible with water quality and biodiversity. But in Canada, conservation of aquatic species and protection of water quality are the main reasons behind the implementation of regulations and protection measures, such as forest buffers along streams, rivers, and lakes. We believe these requirements increase the compatibility between clear-cutting and the preservation of water quality and aquatic species. By polarizing the issue and making the generalization that clear-cutting is incompatible with biodiversity conservation, McNeely simplifies ecological processes and management systems too much. Forests in Canada are dynamic and have the ability to recover from severe disturbances providing that the recovery mechanism has not been affected by the disturbance (Kimmins 1992). Creating large openings in the forest will favour some species and not others. The questions are: are the regenerating forest stands the ones desired? (Botkin 1990); and will the resulting habitat be consistent with the maintenance of biodiversity? Recent research into conservation biology and landscape ecology shows that many species move through the landscape as local conditions change, a key feature to their long-term survival. Through careful management, the forest industry's task is to address the specific needs of those species that do not have the flexibility to move into new habitats. Examples include rare species and those requiring specific types of habitat.

There is no one "right" way to manage a forest because there is no such thing as one Canadian forest. For instance, in a deciduous forest of southern Quebec or Ontario, forest patterns show much smaller patches than those that can be observed in much of the boreal forest. The appropriate management interventions in these two ecozones will thus differ (Environment Canada 1994). In stands with a heterogeneous vertical structure and trees of various ages, selective cutting might be the most appropriate way of harvesting trees. But in a forest stand consisting of conifers of the same age, the best harvesting technique from a practical and "natural" point of view might well be clear-cutting.

Forest fires are dominant disturbances in the boreal forests. Natural fires can burn areas that are much larger than any clear-cut, while releasing enormous quantities of carbon dioxide and other pollutants into the atmosphere. Biodiversity has adapted to these disturbances as well as insect infestations and diseases. Some tree species, such as white pine and jack pine, naturally need fire disturbances for the seeds to have access to the mineral soil or for their cones to open. However, it is also important to recognize that no forest harvesting technique has effects identical to natural disturbances. The key is to minimize these differences in order to minimize the impact on biodiversity.

THE CANADIAN INDUSTRY'S APPROACH Progress in conserving forest biodiversity through forest management is dependent on sound science. An appropriate management technique in one ecosystem might not be applicable elsewhere. In Canada, the forest industry is currently addressing biodiversity conservation through various approaches. One of these approaches, as exemplified above, is to emulate natural disturbances as much as possible, aiming at conserving biodiversity through time and space. This approach relies on the assumption that conservation of biodiversity must allow for the inevitable consequences of natural disturbances and that biodiversity survives through such disturbances.

Another approach is to focus on indicator species, determining their needs and managing the forest accordingly. For instance, in some ecosystems, such as the coastal forest in British Columbia, Canada or the deciduous forest in southern Ontario and Quebec, natural large scale disturbances are not the main factors driving the forest dynamics. The indicator species approach alone might be more suited here, along with careful monitoring.

In both approaches, monitoring programs are required to refine and assess the efficiency of these methods. In light of the information gaps in the specific requirements of most wildlife species, together these two inferential approaches along with careful monitoring might be among the best strategies to adopt for a large part of Canada. It is a strategy that strives to achieve sustainable forest management while considering the needs of all forest species.

A CHALLENGE AHEAD In the world's collective effort to ensure that forests can satisfy the many demands placed upon them, it is critical to avoid making generalizations that are not supported by scientific evidence. Participants in forestry debates must avoid simplifying forestry techniques into good-and-bad polarities, particularly when some harvesting techniques are, in fact, adapted to specific ecosystem conditions. They must remember that any proper balance between the various criteria of sustainable forest management must be determined locally through a consultation process that involves all stakeholders, including those who derive direct benefits from the forest through employment or related activities.

Achieving sustainable forest management will have to consider three basic realities:

- the world's forests have a limited production capacity;
- the world population continues to grow; and
- the pressure on forests comes from many different sources and sectors.

Every year a portion of the five million hectares required to increase food production comes from converting forests to crop land (FAO 1996). The principal agent of forest ecosystem loss worldwide is the conversion of forests to agricultural systems (UNEP 1996).

In developed countries we will need to go further in the direction of sustainable forest management, while maintaining efforts in reusing and recycling wood products. As stated in the Brundtland Commission's 1987 report, *Our Common Future*, "The crucial task is to balance the need to exploit forests against the need to preserve them." It is a balance and a responsibility we all must share, both for the health of the forests, and the well-being of present and future generations.

"No forest harvesting technique has effects identical to natural disturbances. The key is to minimize these differences in order to minimize impacts on biodiversity." (Photo by Don E. McAllister)

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Clear cut decisions in Temagami not so clear cut

by John Hodgson

...I live in Temagami in Northern Ontario. You read about Temagami when Earthroots, Toronto-based environmental activists, sent a squad of young people to the Owain forest to learn civil disobedience and protect the old-growth forest.... They never learned the Owain forest has been lumbered at least twice since 1866. It is a monument to sustainable forestry. They were not taken to the White Bear forest reserve where a huge tract of real old-growth is preserved in a cooperative effort by Temagami Township, the local native people, and the Ministry of Natural Resources.

These youngsters were really no more ignorant of the North than are most southerners. Earthroots and similar groups are skilled media manipulators. Southerners equate Northern Ontario forests with Clayquot Sound. They confuse clear cutting with the lunacy in British Columbia, where cutting the side of mountains has caused wide-spread erosion.

Our Northern pine forests are part of a fire-based ecosystem. The trees get old, diseased, rot. Eventually lightning strikes, and fire sweeps the forest, sustaining the ecosystem and promoting new growth. The government has banned clear-cutting of red and white pine in the Temagami region, although clear cuts are useful. Where the forest is diseased, the larger the cut the better chance new trees have of avoiding disease or parasites in nearby forests. Some experienced foresters question fire prevention as doing more harm than good to the forest's health. In the Temagami region vast tracts have been reserved for parks, and the allowable annual cut outside the parks is only one per cent. Hardly a rape of the forests.

Northerners know this...[But] we must be driven out so that the North can revert to a pristine wilderness, only enjoyed by summer visitors. Yet Earthroots and the threat of civil disobedience has hurt tourism. Bookings are the lowest in 20 years. Temagami is portrayed as an eco-wilderness, devastated by lumber barons and mining tycoons.... We have thousands of trees, magnificent lakes, and a natural resource industry that is responsible. Come and see for yourself.

Biodiversity and Ecological Responsibility

A Reply to Simon Nadeau and Jean-Pierre Martel by Alan Drengson and Duncan Taylor

The main issue is how to turn caring into ecologically responsible practices...

1. We share the concern for forest biodiversity and its conservation. Ecological responsibility requires preserving ecological diversity — a necessity for sustainability. Ecological responsibility requires action. Since we lack complete knowledge, it is wise to err by doing less to interfere with natural systems.

2. Preserving forest biodiversity depends on sound science. However, ecologically sound science is obscured by the clash of paid specialists. Work cited in current debates is often narrowly focused research done using the limited approaches that gave us industrial agricultural models for turning natural forests into biologically impoverished plantations, as well as impoverishing local economies. (For in-depth discussion, see Paul R. Ehrlich and Anne H. Ehrlich, *Betrayal of Science and Reason*, 1996; J. Stan Rowe, "A New Ecology?" in *The Trumpeter*, Fall 1997; our introduction to the anthology *Ecoforestry: The Art and Science of Sustainable Forest Use*, 1997.)

3. Sustaining biodiversity requires a balanced, integrated approach. Current management models do not preserve biodiversity. They focus too narrowly on "preferred" species and profits, and lack comprehensive ecological understanding of natural and human communities. They do not include *all* interests and values at stake. A full cost accounting, multi-values approach is needed, such as ecoforestry.

4. Developing certification for sustainable forest management is good, but a credible certification system must be run by people with no economic stake in the results. Vested interests rarely take care of the public and ecological good. Third party auditors must understand that responsible forest use preserves biological, cultural, ecological, economic, and technological diversity.

5. Our forests are dominated by large scale industrial forestry, which uses large clear cuts and little natural

Continued on page 47

Forum Feedback

The Canadian Museum of Nature is pleased to provide an open forum for diverse viewpoints even though they may not represent the views of the Museum itself. Comments on articles in *Global biodiversity* and any biodiversity issues are welcomed. Anonymous contributions will not be published. Please note: by sending in your views, you give the Canadian Museum of Nature permission to publish your views on our web site <http://www.nature.ca/english/gbfor.htm> and/or in *Global biodiversity* magazine. We reserve the right to edit or condense comments as required. E-mail: <cripley@mus-nature.ca.> Fax: 613-566-4763. Mail: *Global biodiversity* Forum, Canadian Museum of Nature, P.O. Box 3443, Station D, Ottawa, Ontario Canada K1P 6P4.

CONFERENCE REPORTS

WORKSHOP ON NATURAL HISTORY/NATURAL RESOURCE DATABASES AND MAPPING

Dateline: Kemptville, Ontario,
Canada
February 1997

Reporter: Fred Schueler,
Biological Checklist of
the Kemptville Creek
Drainage Basin (BCKCDB)

Editor's Note: The following regional activity serves as a model for more participatory community involvement in discovering and caring for biodiversity.

We invited anyone interested in using georeferenced data to understand the land and biota of Eastern Ontario, Canada to our workshop. Our invitation list included naturalists, natural scientists, museum workers, land managers and stewards, natural history database proprietors, resource extraction managers, students, and landowners. Our purpose was to discuss the compatibility of databases and their use in understanding the ecology, biota, and human occupancy of this area. This meeting was co-sponsored by BCKCDB and the Eastern Ontario Model Forest (EOMF). We provided the agenda, and the EOMF provided the room.

Thirty people came and instead of breaking into separate groups, we spent the day talking around the table, each sharing who we were and what we were doing. At the very least, the meeting allowed solitary researchers and consultants to meet and exchange ideas and data. We discovered that an impressive number of us store our database backups in separate buildings from our systems, and we look forward to using CDs for archival storage.

The meeting was informal. Most participants' work was posted in one-page abstracts. The databases we discussed are used for many purposes, including identifying and cataloguing specimens, modelling predicted occurrence of species, classifying sites and species, coordinating conservation action, biogeography, phenology, and land management. Nobody proposed a grand intermingling of databases into an overarching scheme. There were the usual calls for checking the reliability of data, for more support for data acquisition and study, and for keeping established databases current. The closest we came to recommendations or conclusions were:

- don't impose hard-to-enter fields on people who won't use them;
- try to include easy-to-enter fields that may increase the ease with which others can use your data;
- pass data between systems in the form of *.dbf files;
- define fields exactly; and
- there may be a need to pass snippets of x-base code with fields for transforming them from one format to another.

We are going to put the databases listed by participants in an enlargement of 41 databases already assembled by EOMF's INFOCAT.

Since the workshop, two participants have been working on an exercise for the Ontario Ministry of Natural Resources to try to find all the natural history data available for two townships in our area. This emulates what municipalities will have to do under the new Ontario planning rules. When their report is finished, we hope to reassemble the workshop group, at least by e-mail or mail, to see what data they might have missed.

Our next session will be called a "roundtable" rather than a workshop, and this time we will invite people from organizations proposing database standards as well as all those who didn't come to this last meeting. We will ask somebody to speak on formal rules of data integrity in databases. Also, in advance, we plan to send out a query for topics.

AMERICAN INSTITUTE FOR BIOLOGICAL SCIENCES (AIBS)

Dateline: Montreal, Quebec,
Canada
August 1997

Keynote speaker: Desmond Mahon

Editor's Note: Several Canadian Museum of Nature researchers attended the 48th annual meeting of the AIBS, the theme of which was "Biodiversity — Global Issues." They spoke highly of the keynote address by Desmond Mahon, Senior Program Officer, Secretariat, Convention on Biological Diversity, and we thank Mr. Mahon for taking the time to summarize his address titled The CBD: Implementation Phase and the Scientific Community.

Why is an international instrument like the Convention on Biological Diversity (CBD) needed? There is a growing consensus that the conservation of biological diversity is essential for the survival of the human species. We also know that the vast majority of the planet's biodiversity exists in the developing world, particularly in the centres of origin (places where species originated) and centres of diversity (places with a high number of species from the same genus). This is especially true for many food species and usable biological resources. In addition, an unknown wealth of genetic resources exists in these same areas and could be threatened before their true benefit to humankind is realized. There are thus both economic and social reasons for protecting these regions and resources.

The CBD has been in place for just over three years, and in that time, procedures and institutional mechanisms to assist in its implementation (the phase we have just entered) have been established. Moving from the theoretical to the practical stage is more than just an exercise in report writing. There are significant consequences to activities conducted under the guidance of the SBSTTA and under the proposed Protocol on Biosafety. (For details on the recent SBSTTA and Biosafety meetings, please refer to the other reports in this section.)

Implementing the CBD is a huge task. On a rotational basis, the Parties to the Convention are called upon to review national reports on progress in specific areas in much the same way as the Commission on Sustainable Development operates. In areas where there are scientific or technical problems, the SBSTTA is asked to provide advice on ways to advance work or to address a specific problem. By reviewing the associated working papers and proposed work plans, we begin to realize the depth of expertise needed to implement the CBD's conservation and sustainable-use goals.

It also becomes clear that many countries, particularly those in the developing world, may have difficulty meeting the CBD's requirements. The issue, then, becomes one of having the capacity and capability to implement the requirements. In addressing this issue, the CBD, the SBSTTA, and the Ad Hoc Working Group on Biosafety assume that the developed world will help the developing world acquire the capacity to do so by sharing its information, technology, and expertise.

What, then, will be the expectations of and impact on the scientific community as the Convention moves from the design stage to the implementation stage?

There are two fundamental steps to be taken. First, to conserve and permit sustainable use of biodiversity, we must find out exactly what is being conserved and used. Second, to protect biodiversity, we must understand the characteristics and limitations of both the "attacked" and the "attacker." Both steps imply the need for a compendium of the world's biological diversity, including the "hot spots" of centres of origin and the centres of diversity, and a listing of threatened regions, species, or ecosystems. Each of these studies needs specialists in methodology and information handling. Unfortunately, because many of the skills required will be regional or national in character, the methodology or information will not be readily transferable between ecosystems, regions, or countries.

Where will the skills and training required, plus the ability to transfer skills and technology on such a massive scale, come from? The CBD's answer is clear: from the developed world. Does, however, the developed world have the capacity to provide that assistance now? Probably not, but it must prepare itself because the developing world will look to the governments, institutions, and individuals of the developed world for assistance.

In the area of taxonomy alone, there is a critical shortage of trained specialists. Models and practices established in the developed world will have to be adapted for environments in the developing world. This is true for impact assessment models, criteria for determining biodiversity, criteria for determining loss of biodiversity, baselines for judging the effectiveness of measures, risk management models, and risk assessment models. All of these will put a strain on the institutional framework of the developed world, and by association on the academicians and training staffs in these institutions in other words, you.

I encourage you, and the academic institutions and associated bodies to which you belong, to consider these short- and medium-term requirements for the sustainable implementation of the Convention. Governments around the world have made commitments to the CBD's goals in both national and international arenas. Now is the time to make these commitments a reality.

MEETING OF THE SUBSIDIARY BODY FOR SCIENTIFIC, TECHNICAL, AND TECHNOLOGICAL ADVICE (SBSTTA)

Dateline: Montreal, Quebec,
Canada
September 1997

Reporter: Désirée McGraw

Editor's Note: This article draws on the analysis written by the Earth Negotiations Bulletin (ENB) team, and has been edited and condensed by Ms. McGraw. The ENB is a reporting service on multilateral environment and development negotiations throughout the world. For full ENB coverage of this meeting, check out the Linkages site at <http://www.iisd.ca/linkages/biodiv>.

Scientific, technological, and technical experts from around the world came to Montreal with a full agenda in front of them. Five days later they left with some tangible accomplishments. In Plenary, delegates considered the implementation of the pilot phase of the Clearinghouse Mechanism (CHM) and reviewed a progress report on the work of the SBSTTA and the effectiveness of its advice. Two working groups produced recommendations and work programs for the four key areas that the SBSTTA had been asked to examine. These areas are marine and coastal biodiversity, biodiversity in inland waters, forest biodiversity, agricultural biodiversity. The SBSTTA recommendations and programs will be sent forward for adoption at the Fourth Conference of the Parties (COP-4), to be held in Slovakia in May 1998.

MARINE AND COASTAL BIODIVERSITY Work on conservation and sustainable use of marine and coastal biodiversity was relatively uncontroversial, perhaps owing to the strong framework produced at SBSTTA-1 (September 1995) and the first meeting of experts held on this subject in Indonesia in March 1997. However, some NGOs expressed frustration with the SBSTTA's failure to adequately recognize the potential contributions of traditional and local expertise, while other participants wondered if the "roster of experts" would ever become more than a roster. At the close of the meeting, some expressed the need to make greater immediate progress, especially with respect to the adverse impacts of mariculture and the introduction of alien species on marine and coastal biodiversity. For instance, COP-4 could mandate greater involvement by the impressive roster of experts, who could provide peer reviews of the products or activities called for under the work program.

INLAND WATERS Discussions on inland water biodiversity were relatively straightforward, with two exceptions. Should the SBSTTA endorse the Ramsar Convention's criteria for identifying wetlands and should it adopt the IUCN criteria and definitions for threatened freshwater species? Given the scope of the CBD, some delegates questioned whether these criteria were comprehensive enough. In both cases, delegates called for future work and collaboration, but did not specify how or when this would be achieved. The status of work on criteria seems to reflect the delicate balancing act between the SBSTTA's charge to develop scientifically robust standards against its need to make discernible progress.

FORESTS As predicted by many observers prior to SBSTTA-3, the forest agenda proved tricky and controversial. SBSTTA-3 focused on developing a work program on forest biodiversity. Some participants were concerned that this focus did not adequately zero in on the areas highlighted in the COP-2 decision. This decision asked the SBSTTA to provide criteria and indicators for sustainable forest management and ways to mitigate human impact on forests. Other delegates questioned the SBSTTA working on a forest program, given that forests have not yet been a COP thematic agenda item. Other participants felt the resulting work program was neither strategic nor specific on issues such as integration of biodiversity into forest management, voluntary certification, and equitable sharing of benefits.

Some observers noted an effort to shift the lead on forest biodiversity to the Intergovernmental Forum on Forests (IFF), the insitutitional successor to the Intergovernmental Panel on Forests (IPF). The IFF will consider biological questions on forests only within the context of many other issues directly or indirectly connected to forests. Some participants were delighted that the SBSTTA agreed that the activities of their work program on forests should be "in coordination with" rather than the original stronger wording "in line with" the proposals for action of the IPF and with future deliberations of the IFF. In their view, the new wording implies that the SBSTTA forest work program will not be subordinate to or wait upon the IFF outcomes.

AGRO-BIODIVERSITY Some observers were pleased with the joint efforts of the CBD Secretariat and the Food and Agriculture Organization (FAO) on agro-biodiversity issues, citing it as a positive example of the cooperation with other organizations that is so often called for at CBD meetings. A few participants, however, would have preferred SBSTTA-3 recommendations directed at influencing the current negotiations for the revision of the International Undertaking on Plant Genetic Resources for Food and Agriculture in harmony with the CBD. Access and benefit-sharing will continue to be difficult issues, and SBSTTA-3 made no great strides toward addressing their linkage to trade issues. One observer was pleased that the SBSTTA seemed prepared to collaborate with the World Trade Organization (WTO) Committee on Trade and Environment, but said an opportunity was missed to consider working with all WTO activities and committees, such as the group under Trade-Related aspects of Intellectual Property sub-agreement (TRIPs) and the Committee on Agriculture.

TAKING STOCK OF SBSTTA In her address to SBSTTA-3, UNEP Executive Director Elizabeth Dowdeswell posed the question: Could delegates say that the world's biodiversity is in a better state now, five years after Rio, because of their work as scientists and their influence on the COP? When asked privately for their response to this question, most delegates were either non-committal or appeared perplexed. Does this uncertainty stem from a lack of opinion or from a reluctance to denigrate the hard work of the many participants? The answer is unclear. What is clear, however, is the magnitude and complexity of work that SBSTTA-3 is sending to COP-4. The COP's reception of the SBSTTA recommendations and its action on the suggested work programs will, perhaps, provide a better indicator of SBSTTA's contribution to biodiversity conservation.

FIRST, SECOND, AND THIRD MEETINGS OF THE OPEN-ENDED AD HOC BIOSAFETY WORKING GROUP (BSWG-1, -2, -3)

Dateline: Montreal, Quebec, Canada

Reporter: Gilles Seutin

OVERVIEW: Recent progress in DNA technology now allows us to produce organisms that carry duplicate or modified copies of their own genes and genes of unrelated organisms. These genes typically confer new characteristics on the receivers, which are then referred to as living modified organisms (LMOs). While some LMOs, like bacteria engineered to produce antibiotics, are extremely important to humanity, the careless transfer and use of LMOs could have profound effects on biodiversity.

It is not surprising, then, that the Parties to the Convention on Biological Diversity (CBD) recognized the need to be prudent with the use of LMOs and, especially, their release in natural environments. Based on recommendations from an ad hoc group of experts presented in Jakarta in November 1995, the Parties decided to initiate "a negotiation process to develop...a protocol on biosafety, specifically focusing on transboundary movement of any [LMO] that may have an adverse effect on biological diversity." Biosafety, not yet legally defined, designates precautionary practices to ensure the safe handling, use, and disposal of LMOs. For many developed countries, a biosafety protocol would clarify and standardize procedures for exporting biotechnology products; for developing countries, the protocol would be one mechanism to insure technology transfers. To develop such a protocol, the Open-Ended Ad Hoc Working Group on Biosafety (BSWG) was established.

In addition to having important ramifications for biosafety and biological conservation, the work of the BSWG is also critical on another level. The negotiations may lead to the first protocol developed under the CBD. Thus, many see it as a test of the maturity of the Convention and a failure would seriously undermine the CBD's credibility. At present, the target date for a completed protocol is the end of 1998.

A most fascinating aspect of the "BSWG process" is the division that has appeared among both developed and developing countries and the unconventional alliances that have been formed. For instance, Norway defends positions that are often very close to those of most developing countries, while several developing nations with nascent biotechnology industries hold positions close to those of developed countries.

BSWG-1 The BSWG first met in Aarhus (Denmark) in July 1996 where national delegations presented their views on the scope and content of an eventual protocol. Most developing countries argued for a general agreement on biosafety, while several developed nations favoured a protocol limited to transboundary movements. The discussion identified a few areas of consensus and many of dissent. The need for a detailed procedure of advanced informed agreement (AIA) by which transboundary movements could proceed only if authorized by the receiving country was accepted by all. Areas of dissent include the type of LMOs to be covered by the protocol. Should the protocol focus only on LMOs showing new traits, only on those that may have an adverse effect on biodiversity, or only on those intended to be used in nature? Some also argued that LMO products should be covered by the protocol.

It still remains unclear how these divergent positions are going to be resolved. One solution would be to produce a multifaceted protocol that defines different responsibilities and obligations for countries, exporters, and importers of different types of LMOs. For instance, one could imagine a protocol that imposes the transfer of safety information prior to any export of LMOs, while requiring explicit authorization of the importer prior to the transfer of specific types of LMOs. Clearly, many combinations can be thought of and few have been excluded thus far.

BSWG-2 In May 1997, working from "aide-memoires" tabled by Chair Mr. Veit Koester (Denmark), delegates to BSWG-2 started discussing the specifics of many elements of the protocol including the AIA and notification procedures, competent authorities, risk assessment and management, and monitoring and compliance. The aide-memoires listed specific questions related to each issue and delegates were invited to present their national position on each question. At the end of the meeting, governments were invited to submit legal text on the issues discussed for study at BSWG-3. Delegates also requested that the Secretariat of the CBD develop draft articles on a series of institutional and financial matters as well as on final clauses.

BSWG-3 In October 1997 two distinct processes were led in parallel. First, "outstanding items" were examined, including the highly controversial issues of socio-economic considerations and liability and compensation. Socioeconomic considerations have been repeatedly identified as the item most likely to paralyze the negotiation process. Many developing countries are worried that the introduction of LMOs may disrupt the economy and social conditions of their countries, while several developed countries argue that socioeconomic considerations are too difficult to quantify rigorously to be included into risk assessment procedures. Significant progress was made on this issue at BSWG-3, and the question of liability and compensation now appears to be the most contentious one.

Second, delegates reviewed the legal texts submitted by governments and the Secretariat in order to obtain "consolidated" texts. Under this pre-negotiation procedure, no submission is eliminated but proposals are grouped, concatenated, or fused to the extent that they are reciprocally compatible. In most cases, the exercise has reduced a large number of submissions, often 10 to 15, to a small number of fundamentally distinct ones.

LOOKING AHEAD TO BSWG-4 In February 1998, the BSWG will meet again for a first real negotiation session. If the first three BSWG meetings have identified the range of possible options for a biosafety protocol, they have done little in terms of bringing divergent positions together. Thus, the most difficult questions remain to be answered.

For instance, while everybody agrees on the need for an AIA procedure, the spectrum of organism to which it should apply still needs to be defined, and the specifics of the procedure are unclear: who initiates it, how, and when; what information needs to be provided; what delays should there be to respond; etc. Similarly, while everyone agrees that authorizations to import should be based on rigorous risk assessment analyses, and that all countries should have sufficient expertise and capacities in risk management, it is obvious that developed and developing nations have very different views on what is needed to conduct risk assessment and management studies.

The BSWG's objective for its February meeting is to produce a fully consolidated and partly negotiated text of the protocol to be presented in May 1998 to the fourth Conference of the Parties (COP-4) to the CBD. Most delegates and observers have been surprised by the efficiency with which the Chair has led the BSWG discussions so far, and many now believe that the Working Group might be able to meet its end-of-1998 deadline. It is likely that the BSWG-4 will recommend that COP-4 convene two more BSWG negotiation meetings in 1998 and an extraordinary COP meeting at the end of the year for the signing of the protocol.

BIODIVERSITY MEETINGS

18–19 FEBRUARY 1998

Second Annual Commercial and Industrial Hemp Symposium, to be held in Vancouver, British Columbia, Canada.

Contact: *Arthur Hanks, Editor, Commercial Hemp Magazine, Tel: (604) 258-7171; Fax: (604) 258-7144; E-mail: <events@wisenoble.com>*

3–4 APRIL 1998

International Sustainable Development Research Conference, to be held in Weetwood Hall, Leeds, UK.

Contact: *ERP Environment, PO Box 75, Shipley, West Yorkshire BD17 6EZ, UK; Tel: 44(0) 1274 530408; Fax: 44(0) 1274 530409*

18–22 MAY 1998

Eighth meeting of States and Parties to UN Convention on the Law of the Sea, to be held in Kingston, Jamaica.

Contact: *E-mail: <doalos@un.org>, Web site: <http://www.un.org/Depts/ los>*

19–25 JULY 1998

The Dilemma of Ecosystem Management to be held in Florence, Italy.

Contact: *Boris Zeide, School of Forestry, University of Arkansas, Monticello, AR 71565-3468, USA, Tel: (870) 460-1648, E-mail: <zeide@uamont.edu>*

19–25 JULY 1998

Conservation Biology at the Molecular Level to be held in Florence, Italy.

Contact: *Tim King, US Geological Survey, Leetown Science Center, 1700 Leetown Road, Kearneyville, West VA 25430, USA, E-mail: <Tim_King@usgs.gov>*

CLASSIFIEDS

Restoring Nature's Place: A Guide to Naturalizing Ontario Parks and Greenspace. A practical, comprehensive guide to terrestrial and aquatic habitat restoration and greenspace naturalization. For more info, contact: Earth and Spirit Restoration Centre, 270 Main Street, P.O. Box 93, Schomberg, ON Canada LOG 1T0; E-mail: eoutlook@ican.net; Fax: (905) 939-7044. $49.00 + $5.25 S&H (CDN orders).

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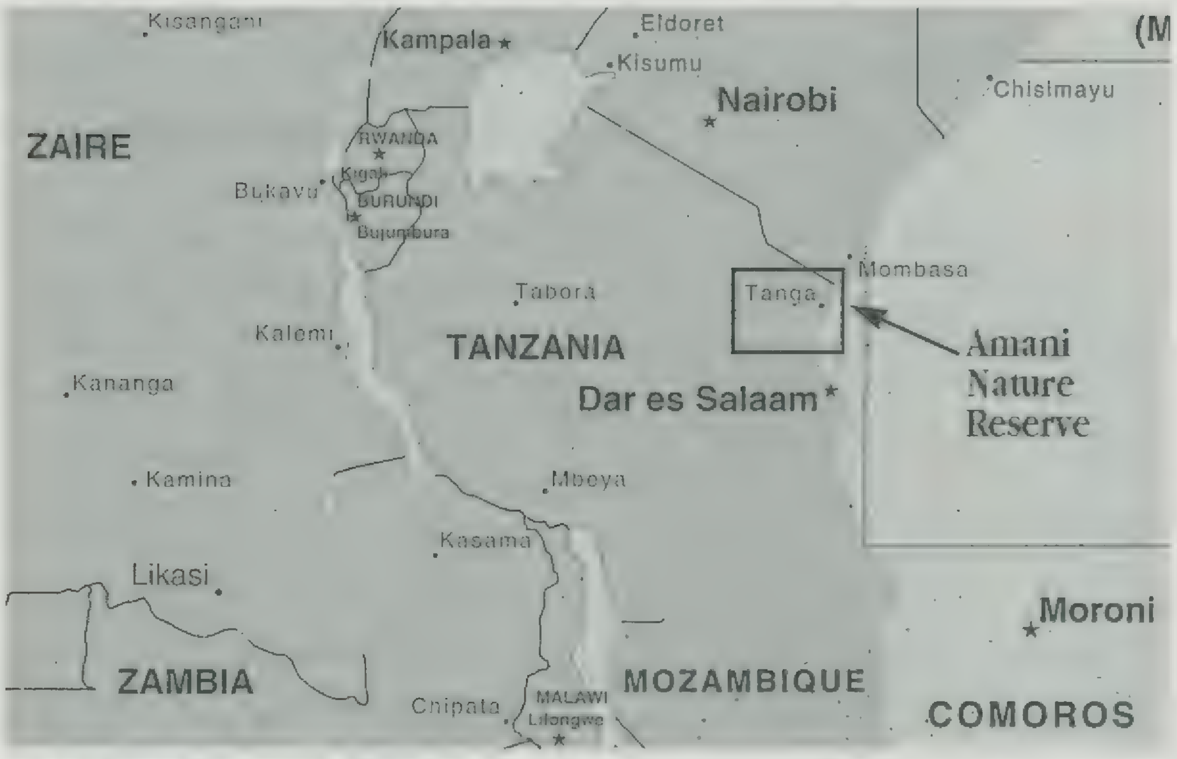
Fax, e-mail, or mail your classified (typed or printed clearly) to: Anne Winship, Ad Manager, Global biodiversity, PO Box 3443, Station D, Ottawa ON K1P 6P4; Tel: (613) 566-4203; Fax: (613) 566-4763; E-mail: <biodiv@mus-nature.ca>.

BIODIVERSITY NEWS



AMANI NATURE RESERVE IN TANZANIA GAZETTED

On 9 May 1997 the government of Tanzania legally gazetted the Amani Nature Reserve in the East Usambara mountains for the protection of the biodiversity, including endemic plants and animals of these submontane rainforests. The East Usambara rainforests are one of the most valuable conservation areas in Africa and one of the biodiversity hot spots and centres of plant diversity of the world.

The East Usambara Catchment Forest Project (EUCFP) has worked to protect the natural forests in the East Usambara mountains since 1990. The project aims to: establish the Amani Nature Reserve; protect water sources; establish and protect forest reserves; sustain benefits the villagers get from the forest; and rehabilitate the Amani Botanical Garden. The project is implemented by the Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism with financial support from the Government of Finland, and implementation support from the Finnish Forest and Park Service. The total financial support for the first two phases, from 1991 to 1998, amounts to US $6.1 million, or about 3.6 billion Tanzanian shillings. [Condensed from an electronic posting by Stig Johansson, Chief Technical Adviser, East Usambara Catchment Forest Project, PO Box 5869, Tanga, Tanzania; Tel/Fax: 255-53-43820, E-mail: <usambara@ twiga.com>.]

JUMA SPEAKS TO CSD

On 11 April 1997 Calestous Juma, Executive Secretary of the Secretariat of the Convention on Biological Diversity (CBD), spoke at the third meeting of Commission on Sustainable Development (CSD) about the experience gained by the CBD to date and about effective arrangements for coordinating activities related to the objectives of the CBD.

"... As we have heard repeatedly over the last three days, the five years since Rio have seen an overall worsening of the global environmental situation. We need to ask ourselves why this has happened. Are there inexorable economic and social forces at play over which we have little or no control? Or is it that we have simply lost the impetus and sense of common purpose that appeared to illuminate the UNCED [UN Conference on Environment and Development] process? Is it perhaps that institutions, like large ships, are slow to pick up speed and change direction, and that these movements are sometimes difficult to detect? I hope it is the latter, and that the armada of sustainable development

agencies and institutions really are in the process of changing course to steer by the same compass and at a greater rate of knots. If this is the case, then the CSD, at this key meeting, must play the role of pilot, offering reliable maps and the right navigational aids to the heads of state who will gather at UNGASS [UN General Assembly Special Session] to decide on the next stage of the voyage. The CBD is a treaty, an international legal instrument. It is a forum for setting policies and priorities, and for promoting the cooperation that is essential for its implementation..... In order for each of us to implement our mandates in an efficient, coordinated, and productive way, institutional synergies and coordination must be actively sought. Agenda 21 and the CBD have mutually reinforcing objectives. This mutuality means that continued cooperation between the CSD and the CBD is essential for both. The CBD reaffirms its desire to maximize the potential for such synergies and efficiencies."

[Excerpt from a CBD Secretariat statement, released 17 April 1997; Photo courtesy of the Convention on Biological Diversity]

FROG TOXINS YIELD ANTIBIOTICS

Professor Chris Shaw and colleagues at Queen's University in Belfast, Ireland report that tropical frog toxins can serve as an extraordinarily powerful set of new antibiotics. The antibiotics do not appear to destroy any human cells, but are active against bacterial strains. The research team believes that the chemical structure of the toxins can be copied to build a new army of antibiotics [*Ottawa Citizen*, May 7, 1997, p. A11.] With existing antibiotics losing potency against drug-resistant bacteria, the news provides hope for doctors. The news also provides hope to developing countries in which the frogs live, should the benefits from this discovery be shared with these countries. Sharing the benefits from biological diversity in this way is one of the cornerstones of the international Convention on Biological Diversity. [D.E.M.]

INDIGENOUS PEOPLES' CONCERN OVER PATENTING OF THEIR GENES

The Human Genome Diversity Project (HGDP) continues to cause concern to indigenous peoples according to an article in *Paragas!* entitled "The Human Genome Diversity Project: Saviour or Desecrator of Life?" *Paragas!* is a publication of the Solidarity Action Group for Indigenous Peoples and the PASAK Regional Lumad Confederation. Members of indigenous tribes that have not intermarried with other peoples are of particular interest to the HGDP. The HGDP hopes to find the genetic secret to human evolution and the history of human migration, and to study the predisposition of certain groups to genetic diseases. Indigenous peoples, says the article, have several objections to the program. These include the reductionist approach of linking people to genes, ignoring their deep relationship to the lands, and devaluing indigenous knowledge, culture, and traditions. Why, they wonder, are international organizations and governments giving priority to indigenous genome concerns, when indigenous peoples' own priorities are not being met? [*Paragas!* 2(2): 6–9].

DEFORESTATION IN SOUTHERN BOREAL FOREST OF CENTRAL SASKATCHEWAN

In January 1997 four Saskatchewan researchers presented a paper entitled "Estimating Changes in Forest Area Between 1963 and 1994 in the Prince Albert National Park Region of Central Saskatchewan, Canada" to the third national science meeting of the

Ecological Monitoring and Assessment Network. The researchers estimated changes in wooded area on a 183,000-hectare study site using digital National Topographic System maps dated between 1963 and 1990. They also used Landsat imagery to estimate the change in forest area over the same study site between 1984 and 1994. The two methodologies show similar annual decreases in forest cover: 0.33% for wooded area between 1976 and 1990; and 0.35% for productive forest area between 1984 and 1994.

This rate of change is greater than the 0.20% global mean deforestation rate estimated by the Food and Agriculture Organization (FAO) between 1980 and 1990. Saskatchewan's forest status may not be unique. A just-released study by the World Resources Institute, *The Last Frontier Forests*, states that 41% of Canada's remaining frontier forest is threatened. [Michael Fitzsimmons, Parks Canada; Peggy MacTavish, Saskatchewan Research Council; Lorena Patino, Centre for Geographic Information Systems, University of Regina; Peter Farrington, Canadian Wildlife Service]

NEW HONORARY SPECIES NAMES FOR SALE

Strapped for funds, many museums are seeking new sources of financial support. The Zoologische Staatssammlung München (ZSM) in Germany has been implementing a new fundraising technique for a year. The ZSM operates as follows:

- donations of DM 5,000 ($4,185) for individuals or DM 10,000 ($8,370) for institutions are solicited for their choice of an animal;
- the donor gets a document confirming the patronomy, the species is named after the donor (or someone chosen by the donor), the donor gets an original graphic of the animal (of which a copy is published), and ten reprints of the published paper. Documents and graphics are presented at celebrations twice each year.

A supporting society, Freunde der Zoologischen Staatssammlung, administers the funds for zoological research. The money is used to buy collections or books, to support scientific travel, or to purchase urgently needed equipment. [*Nature* 386: 641, 17 April 1997].

The approach has considerable merit. It raises, in the face of government cutbacks, desperately needed funds. It raises the profile of taxonomic work. It draws attention to the number of new species being described and the number yet to be described. And last but not least, it forges a link between people and wild species. Names are powerful spiritual symbols. [D.E.M.]

INSURANCE AND BANKING FIRMS LINK WITH UNEP IN CONCERNS ABOUT ENVIRONMENT

In November 1995 the United Nations Environment Programme (UNEP) began an alliance with major insurance companies and the commercial and investment banking sector. This produced a Statement of Environmental Commitment (SEC). The common concern was that environmental disasters induced by human activities can bankrupt industry. Of special concern is global warming due to higher emissions of greenhouse gases. Not only will higher levels of these gases increase global warming, but they will probably increase the frequency and strength of storms and the damage done by wind and floods. The signatories to the SEC formed a lobbying group and tabled a position paper at the July 1996 Climate Change Convention. Over 70 major insurance companies are now participating. Nearly 100 commercial banks have now signed a similar UNEP banking statement. The Third UNEP banking roundtable, held in May 1997 at Columbia University, New York, US, furthered the alliance. [UNEP News Release, May 1997].

CELEBRATING OUTDOOR CLASSROOMS

On 2 May 1997, students and teachers around the world celebrated International School Grounds Day. The day originated in the UK with the organization "Learning through Landscapes," and celebrates the involvement of children in changing their school grounds into places where they want to be. Plans are underway for a 1998 celebration, and schools are invited to register their events by 22 April 1998. For information, call (416) 465-1597 or visit <http://www.gbr.org/school>. [From Green Brick Road press release, 21 April 1997]

CANADA BANS LEAD SINKERS AND JIGS IN PARKS

Since January 1997 the Canadian government has banned the use of lead sinkers and jigs in Canadian national parks and wildlife areas. The ban extends to anglers who have lead sinkers and jigs in their tackle boxes, even if they aren't fishing with them. [From an American Sportfishing Association note in *Fisheries* 22(4).] To find out more about the harmful effects of lead on the freshwater ecosystem and the success of the Bi Logic Tackle Company to produce lead-free sinkers and jigs, see *Global biodiversity* 5(1): 15.

RESEARCH IS KEY TO ECOLOGICALLY SOUND FOREST MANAGEMENT

On 25–28 May 1997, the Ad Hoc Liaison Group on Forest Biological Diversity met in Helsinki, Finland to identify the priorities for a work program on forest biological diversity under the Convention on Biological Diversity (CBD). The program is being prepared in cooperation with the United Nations Intergovernmental Panel on Forests (IPF). The meeting focused on forest ecosystem management, criteria and indicators for best forest management practices, development of technology, and traditional knowledge. Its aim was to assist the Secretariat in preparing a focused work program on forest biological diversity for consideration at the Conference of the Parties (COP-4). The group made significant scientific and technical contributions to the efforts of the CBD to integrate biological diversity into sustainable forest management practices. Progress was expected in these areas at the third meeting of the SBSTTA. (See page 30 for a report on the SBSTTA meeting.)

In addition to greater involvement by the scientific and technical community, the Secretariat is exploring ways of promoting private-sector participation in the work of the Convention, especially in the area of technology development. For more information, please contact the Secretariat of the Convention on Biological Diversity, Tel.: (514) 288-2220; Fax: (514) 288-6588; E-mail: <biodiv@mtl.net>; Web site: <http://www.biodiv.org>.

GREEN HOTELS IN THAILAND

On 26 March 1997, the Board of Environmental Promotion of Tourism Activities of Thailand launched the Green Leaf Programme to promote standards for environmental management in hotel operations. The Board is composed of the Tourism Authority of Thailand, the Thai Hotel Association, UNEP, and other relevant organizations.

Under the program, experts from various organizations will judge the environmental practices of the participating hotels. Hotels are inspected and then awarded one to five green leaves, depending on the level of the hotel's environmental management efficiency. The ratings will be publicized in the *Green Hotel Directory* produced by the Tourism Authority of Thailand's worldwide network of overseas offices. The directory will benefit environmentally conscious travellers and motivate participating hotels to improve environmental protection. The Green Leaf Programme will update the Green Leaf ratings every two years. [*UNEP Executive Director's Update* March 1997; 3(3): 4.] Thailand is to be commended for this green step forward. Maybe this program will be emulated by tourism bureaus and hotel organizations in other countries. [D.E.M.]

BIODIVERSITY INCLUDED IN NEW SASKATCHEWAN *WILDLIFE ACT*

Saskatchewan amended its *Wildlife Act* this summer to include the province's biological diversity. "Wild species" are now defined as any plant, animal, or organism that is wild by nature. This includes pollen, spores, eggs, sperm, embryos, and any part, tissue, or genetic material of a plant, animal, or organism. The change represents a significant shift in the approach taken to conserve the province's biodiversity. In addition, the Act was amended to include provisions for protecting wild species at risk. For more information, contact the Fish and Wildlife Branch at 3211 Albert Street, Regina, Saskatchewan, Canada S4S 5W6, or telephone (306) 787-2314. [Special thanks to Paul James, Biodiversity Specialist, Fish and Wildlife Branch, Saskatchewan for letting us know about this.]

CANADIAN GOVERNMENT GETS "A" FOR LAND BUT ONLY "D" FOR MARINE WILDERNESS PROTECTION

In April 1997 World Wildlife Fund Canada released its annual wilderness report on the protection of wilderness areas, the *1996–97 Endangered Spaces Progress Report*. The federal government protected over 60,000 km^2 of wilderness lands, including two new national parks, Wapusk in Manitoba and Tuktut Nogait in the Northwest Territories, totalling over 28,000 km^2. Industrial development in the proposed Wagner Bay and Bathurst Island national parks was cancelled, protecting another 32,000 km^2. Additional lands were acquired for a Gulf Islands national park in BC. These efforts earned an "A." In stark contrast the federal government earned a "D-" for letting another year pass without establishing any new marine protected areas. [World Wildlife Fund News Release, 29 April 1997).

WETLAND BUFFERS IN CANADA AND USA NOT ADEQUATE

In their study of 30 southeastern Ontario wetlands, Scott Findlay and Jeff Houlahan of the University of Ottawa observed that the number of species of birds, amphibians, and plants was negatively correlated with the density of paved roads within 2 km of the wetland. Their study also found positive relationships among mammal, amphibian, and reptile diversity and the amount of forest cover within 2 km. These results suggest that narrow buffer zones around wetlands in Ontario and elsewhere may be inadequate to conserve wetland biodiversity. For more information read the authors' full report published in *Conservation Biology*, August 1997. You can contact Scott Findlay by calling (613) 562-5800 ext. 4574; faxing: (613) 562-5486; or e-mailing <sfindlay@science.uottawa.ca> or Jeff Houlahan by e-mailing <jeffh@sonetis.com> [*GL Habitat Watch* #79/80, published by Great Lake United's Biodiversity and Habitat Protection Task Force. E-mail: <glu@igc.org>.]

CHIEF SEATTLE NEVER SAID THAT...

On the back cover of *Global biodiversity* 7(2) we published a quotation "reputed" to have been said by Chief Seattle. Thanks to Stephen Strauss and Hugh Danks for pointing out that Chief Seattle never actually said these words. Ted Perry, a screenwriter scripted these words for the character of Chief Seattle to speak in the 1972 environmental movie "Home."

CYBERDIVERSITY

CHECK OUT PROGRESS ON IABIN

The Inter-American Biodiversity Information Network (IABIN) is an intergovernmental initiative intended to promote greater coordination among the nations of the Americas in collecting, sharing, and using biodiversity-related information. The proposal to develop IABIN was adopted by heads of state and governments of the Americas at the Santa Cruz (Bolivia) Summit on Sustainable Development, in December 1996.

Meetings were held by the US Department of the Interior with interested federal agencies and non-governmental organizations in March 1997. Presentations addressed pre- and post-Summit planning for IABIN, and the US National Biological Information Infrastructure (NBII), Global Information Locator System (GILS), and other systems in use.

Because IABIN is new, change is constant. To view current information on IABIN, including materials from past meetings, you are encouraged to visit the site at <http://www.nbs.gov/nbii/iabin>. Ideas, suggestions, and comments are welcome. Browsers should note that the material presented in this notice and at the web site is based on US interpretation of discussions concerning IABIN and does not, at this time, reflect international consensus or agreement, except in an informal sense. [From a 4 June 1997 posting on the biodiv ListServ.] For more information, contact: Robin O'Malley, Office of Policy Analysis, US Department of the Interior, E-mail:

<romalley@ios.doi.gov>; or Gladys Cotter, Assistant Chief Biologist – Information, Biological Resources Division, US Geological Survey, E-mail: <gladys_cotter@nbs.gov>.

US NMNH DIVISION OF BIRDS

The US National Museum of Natural History's (NMNH) Division of Birds now has its own web site. The site contains a searchable database of nearly 4,000 primary type specimens in the NMNH collections as well as an index to the NMNH general collection holdings in a searchable gopher file. The site also contains visitor information, loan and destructive sampling policies, a staff list, and links to other museum and ornithology web sites. The URL is <http://nmnhwww.si.edu/vert/birds/>. [*ASC Newsletter* April 1997, 25(2): 24]

KEW'S LIST OF VASCULAR PLANT FAMILIES AND AUTHORS OF PLANT NAMES

The Royal Botanic Gardens at Kew, London, UK, have made two important databases available on the Internet: *Vascular Plant Families* and *Authors of Plant Names*. One can search for details of a generic name or author, seek data on an author standard form, view a list of genera within a family, and download the data to a local personal computer. The URL is: <http://www.rbgkew.org.uk/web.dbs/webdbsintro.html>.

NEW SSC WEB SITE

The IUCN's Species Survival Commission (SSC) has a new web site. The site provides general information about the SSC, lists and ordering information for SSC's publications, names and contact information on specialist groups, draft guidelines for invasive species for comments, the text of the analysis from the 1996 Red List, full Analyses of the Proposals to Amend the CITES Appendices, and much more. The site's URL is: <http://www.iucn.org/themes/ssc/index.html>. [Elizabeth McCance, IUCN SSC, Chicago Zoological Society, Brookfield, Illinois USA 60513].

RAMSAR FORUM UNDERWAY

The Bureau of the Ramsar Convention on Wetlands is pleased to announce the launch of the Ramsar Forum, an e-mail mailing list devoted to the wide range of news, announcements, queries and replies, and statements of opinion concerning the conservation and sustainable use of wetland resources in general, and the Ramsar Convention in particular. There are currently 101 contracting Parties to the Convention, which have designated 872 sites for the Ramsar List of Wetlands of International Importance, covering over 62.5 million hectares of Earth's surface area.

The Ramsar Forum is an official service of the Ramsar Bureau and all interested persons are encouraged to join; messages are welcome in any of the Convention's three official languages (English, French, and Spanish). Send an e-mail message to: <ramsar-mgr@indaba.iucn.org>. The subject line can be left blank, and your message should read: "join ramsar-forum".

The welcome message you will receive is also available on the Convention's web site <http://iucn.org/themes/ramsar/index.html> in the "What's New" section.

FAO PLANT BREEDING NEWSLETTER NOW AVAILABLE ONLINE

Aware of the importance of plant breeding as a tool for enhancing agricultural production and its sustainability, the Food and Agriculture Organization (FAO) of the United Nations is hosting an electronic newsletter called *Plant Breeding News* (PBN). Co-sponsored by the FAO's Plant Production and Protection Division, the FAO's Plant Breeding and Genetics Section of the Joint Division, and the International Atomic Energy Agency, PBN is intended to provide a dynamic and informal forum for information exchange between plant breeders and others interested in the effective use of plant genetic resources.

By subscribing, you will receive one edition of PBN monthly. To subscribe, send an e-mail to: <mailserv@mailserv.fao.org>. Leave the subject blank and write in the first line of the email message: <SUBSCRIBE PBN-L>.

Each PBN edition will have a number of sections based on crop groups and thematic issues. The sections may change over time based on suggestions from users. At present, topics fall into two main categories: crops (such as cereals, roots and tubers, horticultural, industrial, and pulses and oil-seed legumes) and a disciplinary area (including editor's notes, technology and breeding methods, biotechnology, diseases and pests, and abiotic stresses). [Special thanks to Claude-André St-Pierre for forwarding this announcement to us.]

Send us your news!
Please keep us up to date on your group or organization's activities, campaigns, reports, web sites, and/or meetings.

Contact:
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NEW CITES INFORMATION SERVICE

The World Conservation Monitoring Centre (WCMC) has launched a new CITES (Convention on International Trade in Endangered Species of Fauna and Flora) prototype information web site. The site contains an interactive database for CITES-listed species plus resolutions and decisions from past COPs. Where possible, these are posted in the three official lanaguages used by CITES (English, French, and Spanish). The URL is: <http://www.wcmc.org.uk/CITES/english/fauna.htm>.

DATA BANK OF CANADIAN SYSTEMATISTS ONLINE

The Canadian Museum of Nature has posted a list of systematists and taxonomists working in Canada and their fields of expertise on its web site. This posting results from the Museum's concern about the declining support for systematics and taxonomy in Canada. Without increasing capacity and funding in this area, Canada will be hard-pressed to meet its obligations to the Convention on Biological Diversity. The Museum envisions the Data Bank of Canadian Systematists as a growing, evolving, and interactive storehouse of information, which will aid individuals, private sector companies, or governments who may need knowledgeable individuals with this scientific expertise. The list will be updated on a regular basis, so if you have expertise in these areas and are not listed, you are encouraged to send the appropriate information to <cripley@mus-nature.ca>. The URL for the list is <www.nature.ca/english/system.htm>.

STAY POSTED ON THE LATEST ENVIRONMENTAL NEWS STORIES

The Planet Ark Environmental Foundation is now hosting environmental news from Reuters on their Web site. Stories are posted daily. Check it out at <http://www.planet.ark.com.au/>.

BIODIVERSITY POLICY JOURNAL GOING STRONG

Launched in 1996, the *Biopolicy Journal* is a low-cost way to distribute authoritative papers on biopolicy. The peer-reviewed papers are distributed through the web, and the journal is associated with a number of other services (e-mail, discussion forum, news, links to other biopolicy sites). Author guidelines are available on the site or by request from <biopol@biostrat.demon.co.uk>. The URL is <http://www.bdt.org.br/ bioline/py>.

INTERESTED IN ENVIRONMENTAL TECHNOLOGY?

If so, be sure to visit the bilingual web site of Enviro-Access. Enviro-Access is a non-profit corporation that supports the "launching and growth of firms [primarily in Quebec and Eastern Canada] involved in the development and the marketing of environmental technologies, in order to solve environmental problems at the national and international levels and to promote the creation of wealth within our economy." The site contains fact sheets, contact information for scientific experts, a business directory, annual report, and listing of conferences. The URL is <http://www.enviroaccess.ca/>.

COMING SOON!

SPRING 1998

Patenting Plants: Piracy or Progress?

Advantages of Agri-Pulp for Paper

Freshwater Ecosystems

State of Forest Management for Biodiversity

Successes and Initiatives:
- Montreal Biodome
- Canadian Institute for Business and the Environment
- Institute of Biodiversity and Environmental Conservation, Malaysia

FORUM: Will the MAI limit the power of democratically elected governments to protect the environment?
You tell us! Go to <http://www.nature.ca/english/gbfor.htm>.

BOOK REVIEWS

The Forgotten Pollinators

Stephen L. Buchman and Gary Paul Nabhan. 1996. Shearwater Books/Island Press. 320 pp. ISBN 1-55963-352-2. Cloth. US.$25.00.

In more traditional societies the importance of pollinators and the act of pollination are still ritually acknowledged in sacred ceremonies. In urban/industrial societies many — including biologists — have "forgotten" this key ecological link. And with forgetting comes not only a loss of knowledge, but also a physical loss. With the mixed tone of an ecology primer and detective story, *The Forgotten Pollinators* carefully documents numerous cases worldwide of decline in pollination interactions.

The honeybee, *Apis mellifera*, gets central billing in this pollination drama. As an indicator of the complexity of the issue, *Apis mellifera* receives both good and bad reviews. The authors emphasize its importance as a key agricultural crop pollinator. At the same time, they note the damage *Apis melilifera* has wreaked on indigenous North American pollinator populations and their obligate mutualistic partner plants.

In the United States honeybees currently pollinate about 80% of all commercial crops. As the authors note, "the value of honeybees far outweighs their value as honey producers." Yet *Apis mellifera* has colonized North America in both the biological and cultural senses of the word. Introduced over 375 years ago by European settlers, the honeybee is emblematic of the ecological changes created by a highly adaptable introduced exotic. A social bee with a large and rapid nectar and pollen foraging capacity, *Apis mellifera* has probably caused the demise of numerous indigenous pollinators.

Apart from introduced competition, habitat destruction worldwide is having a significant, if invisible to most, impact on pollination relationships. For flowering plants this relationship breaks down due to pollinator limitation — there just aren't enough bees, bats, beetles, or other pollinators visiting flowers and transferring pollen. In North America, and particularly in the Sonoran desert in Arizona, US with which the authors are most familiar, this decrease in pollinators is due to "chemically induced habitat fragmentation" — the result of intense agricultural pesticides killing large percentages of native pollinator populations. And the loss of the insects endangers the endemic plants that depend on them for pollination.

Written as a series of remembrances by the authors, both skilled field observers and storytellers, *The Forgotten Pollinators* tells a compelling tale that is scientifically rigorous. The decision to focus on an interaction rather than a species represents an increasingly important approach to understanding biodiversity loss: it is "more than the simple loss of species; [it is] the extinction of ecological relationships."

An innovative collaboration between researchers, environmental activists, and a public museum, the book is a keystone in the Arizona-Sonora Desert Museum's Forgotten Pollinators Campaign. As such, the appendices include a ten-point proposal for a National Policy on Pollination (generally applicable to any country), and a glossary of relevant conservation and resource organizations.

Not to leave the reader relying solely on a formal, organized national response, *The Forgotten Pollinators* concludes with a suggestion for a partial but immediate remedy. The final chapter encourages readers to be backyard insect watchers and to create pollinator-oriented gardens of their own.

Jacob Berkowitz, Communications, Canadian Museum of Nature, Ottawa, Ontario, Canada.

Islands: Biological diversity and ecosystem function

Ecoligical Studies, Vol. 115. Edited by P.M. Vitousek, L.L. Loope, H. Andersen. 1995. Springer-Verlag, New York. ISBN 0-387-57947-8. 258 pp.

There is a feverish race underway to find markers of global change so that we can better develop policies to avert deterioration of the biosphere as well as ecological disasters. This lean volume explores the potential of oceanic islands as markers for better ecosystem management on continents. This book is the proceedings of the 1993 Workshop on Biological Diversity and Ecosystems and Ecosystem Function on Islands held in the Bahama Islands under the auspices of SCOPE (Scientific Committee on Problems of the Environment).

The editors begin by outlining the centrality of oceanic islands to 19th century biology, particularly to the pioneering notions of evolution and speciation of Darwin and Wallace, and to the paradigms of contemporary conservation science, especially the theory of island biogeography. Early on the editors argue that "lessons learned from success and failures in conserving the biological diversity on islands might guide us in developing strategies for protecting continental diversity." But exactly what can islands tell us about larger terrestrial ecosystems and how to conserve them? According to this book, the jury is still out.

All the articles in the book confirm that island conditions are often unique and that island biota are often vulnerable. Beyond these axioms, it becomes clear that while islands can give us many insights, the patterns gleaned from "island life" are often contradictory and are not always directly transferable to conservation in larger, more landlocked areas. There are pressures to make questionable generalizations such as Henning Andersen's statement that "the main worry in continental reserves may be ecosystem contamination in terms of chemical pollutants, whereas island reserves suffer from biodiversity contamination in terms of alien organisms." Alas, in recent decades many islands have suffered the devastating synergies of both invasion of alien species *and* chemical contamination.

This enigmatic book raises far more questions than it answers; it contains many interesting threads that may well preoccupy biogeography and conservation biology for much of the next century including:

- The theme of oceanic islands as anomalous, rather unpredictable, engines of speciation — ones inherently difficult to extrapolate "lessons" from.
- The vulnerability of oceanic island ecosystems, especially to invasions of aggressive and often lethal species. This may suggest that protected areas on continents may well share this devastating fate.
- The implications of the relatively impoverished nature of island biota, compared with similar conditions on mainlands.
- The debunking of the myth that islands are relatively stable environments.
- The surprising fact that virtually all of the so-called "natural" archipelagos that sparked modern biology (except for the Galapagos Islands in Ecuador) have already suffered significant human-induced losses of groups of vertebrates (notably ground birds) and plant species.

Halfway through the book, one begins to wonder if it is not more about how island ecosystems are *less* relevant to conservation on continents than we once thought. For example, J.H. Fownes suggests that the same species may behave ecologically differently on different islands. But other articles discuss subjects such as the intriguing mutualisms associated with island "passengers." It is these frequently archipelago-specific relationships between species that indicate most about the vulnerability of underlying ecological architectures.

The volume is strongest when reviewing and enhancing relatively established debates in biogeography. Its forays into spatial analysis and land management are more limited. Vitousek and Benning's key overview of island landscape ecology was disappointing. (For one reason, the simple commonality of ecosystem types is not fully acknowledged.) M. Maunder's stark description of St. Helena did not foresee much conservation in its future without a considerably increased level of economic development. This article and several others point to an outdated intellectual collapsing of the factors influencing island biodiversity, island ecosystems, and island conservation. This collapsing contradicts the assertions that all oceanic islands, with very few exceptions, have been the products of erratic human, as well as more predictable biogeographic, processes.

For Canadians this book is most relevant to those living in the more far-flung and ice-free regions of the Maritimes and the Pacific Coast — few of which are fully "oceanic." Perhaps the book's greatest contribution is to remind us of the uniqueness of the ecosystems of each insular land mass and that ecological generalizations that work on the mainland may not be enough of a basis for protection of these precious margins.

Gordon Brent Ingram is from Vancouver Island and holds a PhD from Berkeley focused on design of networks of protected areas on islands with primary rainforest. He practices environmental planning in the Pacific Rim and sometimes teaches at the University of British Columbia.

Environmental values in American culture

By Willett Kempton, James S. Boster and Jennifer A. Hartley. 1995. MIT Press. Cambridge, Massachusetts, US. Hardcover ISBN 0-262-11191-8, $42.00; Paper ISBN 0-262-61123-6, $15.00. 336 pp.

Consider the "truisms" of environmental politics:

- concern about the environment is fragile, easily displaced by more pressing matters like crime and taxes;
- people usually focus on short-term, not long-term problems like climate change; and
- environmental politics is about conflicting values.

Such statements are often viewed as beyond debate. But, as *Environmental Values in American Culture* demonstrates, they may also be largely incorrect.

The authors of this book are anthropologists. Using the methods of their discipline, including surveys, interviews, and other strategies customarily applied to the study of foreign cultures, they have generated a series of conclusions about how Americans view their environment. Most important, they conclude that concern about the environment is not a fad.

Over the last 30 years, this concern for nature has become pervasive, and closely associated to other core values, including concern for future generations, parental responsibility, and religious faith. Only a small minority of Americans continue to believe that nature's only function is to serve humanity. And while the media tends to focus on conflict when reporting environmental politics, there actually exists a rough consensus, with most people holding views that could be classified as environmentalist. Even opponents of environmental laws often share these values, although they may give more weight to concerns about taxes or unemployed coal workers.

> "If environmental concerns are so widespread, why does not this translate into action?"

To better understand these values, the authors sought to define the "cultural model" — the underlying perspective on nature. According to this model, nature is an interdependent, balanced, often delicate system, vulnerable to "chain reactions" triggered by human impact and interventions. Such a model tends to imply caution toward such interventions, because of their potentially unpredictable, irreversible consequences.

This cultural model diverges from scientists' understanding of the world. Some ecologists, for example, no longer consider nature to be a fragile balance. Scientists and the public, however, do tend to agree on the implications of climate science: that society should act on the basis of uncertain information, and not wait for final "proof" of climate change.

These conclusions have implications for both education and policy. Those who communicate scientific results to the public should not assume they are writing on a blank slate. Most people are predisposed to protecting the environment, but an understanding of the most effective way of doing so may be less widespread. For example, while specialists see energy conservation as the most effective strategy to forestall climate change, non-scientists see climate change as a problem to be addressed through pollution controls (as have previous environmental problems). As a result, fuel efficiency standards, carbon taxes, or other energy conservation measures may not receive wide support even among those concerned about climate change, because these measures are seen as irrelevant.

This book is strongest in its analysis of contemporary environmental values and their underlying cultural models. It is less successful in addressing an obvious question: If environmental concerns are so widespread, why does this not translate into action? Barriers to action, both economic and structural (for example, the absence of convenient alternatives to private cars), are part of the explanation. Inappropriate cultural models (such as the view of climate change as a pollution problem, not an energy issue) also justify ineffective personal actions or policies. Strong corporate influence on elected officials is another likely possibility.

As the authors speculate, environmental values are necessary, but not sufficient, to generate effective environmental action. Overall, this book is an extremely valuable examination of public environmental values. It succeeds in transcending the simplistic generalizations generated by public opinion polling and a news media committed to portraying conflict.

Stephen Bocking, Environmental & Resource Studies Program, Trent University, Peterborough, Ontario, Canada.

In land we trust: Environment, private property and constitutional change

Edited by Calestous Juma and J.B. Ojwang. 1996. Initiatives Publishers, Nairobi, Kenya and Zed Books, London, UK. Paper ISBN 1-85649-418-7, US $29.95. 462 pp.

Land tenure patterns significantly affect resource management practices, and this is particularly seen in those countries colonized by European governments in the last couple of centuries. In these countries, Western notions of private property have been layered over customary laws and institutions. *In Land We Trust* focuses primarily upon the tenure regimes coexisting in Kenya ("modern" private property, public trust land, and extensive customary rights), but also draws from wider African, North American, and European experiences.

Within historical and contemporary contexts, the book sets out the constitutional, legal, political, and practical influences at work on Kenya's tenure and governance systems. It analyzes the links between customary, communal rights and sustainable land use, and demonstrates the limitations of a private property regime (e.g. over-parcelization, overexploitation, consolidated use rights, landlessness, absentee landlords, fencing and use barriers to migratory wildlife, and the undermining of traditional authority).

As in other former British colonies such as Malaysia, India, and Canada, Kenya's customary institutions, laws, and practices have been weakened through colonial and post-colonial administrations to facilitate access to resources. Yet for extensive and arid regions customs persist in law, and elsewhere, they exist in practice. Such customary rights of access, authorities' controls, and private rights derived from personal labour are distinguished from a free, open access regime, and thus from Hardin's "tragedy of the commons." They are presented as responsive, resilient, complex, and less risky, thereby suiting the ecosystems with which they are intertwined.

In Land We Trust makes an important contribution to biodiversity policy. It documents models and insights for Kenya and other countries that challenge Western individualistic and private property rights, which are so often uncritically embraced. It further advocates public interest in and private responsibility for biodiversity conservation. The authors of the various essays propose various means and rationales to weave this latter approach into current institutions, often drawing from customary rights models (e.g. pastoral, tree, and medicinal plant tenures). Such means include:

- constitutional and practical recognition of customary rights and authority;
- making property rights explicitly subject to good stewardship;
- developing a public trust doctrine and appropriate decision-making principles;
- recognizing the rights of living forms; and
- encouraging public and local institutional development and participation.

In their search to address biodiversity losses and to successfully integrate environmental, economic, and social dynamics, both globally and locally, the authors frequently express concerns about private property and the need for a stewardship ethic. One might conceive of a hybrid approach: Western regulatory powers and land trusts' acquisitions expanding to reflect public interests over private lands, with communal tenures incorporating recognition of individual rights. Guided by its editors (one of whom, Calestous Juma, is also Executive Secretary for the Secretariat to the Convention on Biological Diversity), the book illuminates such discussions.

The book's value is enhanced by its broad African scholarship and the inclusion of some comparisons to non-African experiences, such as the canvassing of Canadian constitutional, public participation, and environmental law. While making its case, however, the book occasionally overemphasizes US analytical frameworks and case law concerning property rights, which have legally and politically undermined environmental regulatory initiatives in that country.

As one of the authors notes, development has focused largely upon technology and not upon attitudes and social understandings of land-use systems. This fascinating, in-depth review of tenure and conservation issues is instructive for readers, whether they are familiar with the Kenyan experience or not. There are few such collaborative efforts to understand the interaction of customary and Western law and policy, and their influence upon biodiversity conservation, and yet these efforts are much needed. *In Land We Trust* demonstrates the results and benefits of such long-term analyses and creative, considered proposals.

Ian Attridge, editor of the book Biodiversity Law and Policy in Canada, *and environmental lawyer, Peterborough, Ontario, Canada.*

Prairie conservation: Preserving North America's most endangered ecosystem

Edited by Fred B. Samson and Fritz L. Knopf. 1996. Island Press, Washington, DC, US. ISBN 1-55963-427-8. Paper, 339 pp.

After reading this book one can have little doubt that the prairie is North America's most endangered ecosystem, as well as one of its most fascinating. The book examines many aspects of the prairie and of prairie conservation and readers are brought up to date on the various initiatives underway to conserve this once vast landscape.

The book is divided into four parts and starts with a discussion of the value of the prairie from a historical perspective. The economic value of the prairie and the difficulties of trying to assign value to some of the consumptive and non-consumptive uses are examined.

The second section deals with the major prairie types of tallgrass, shortgrass, and with the mixed prairie. A chapter on prairie wetlands is a welcome addition to this section; it discusses the five major pothole regions of the Great Plains and notes water bird use and historical changes in each. It should be noted that the book deals only with grassland types that are commonly referred to as prairie in the Great Plains region of the continent. This may be the reason that no mention is made of the rich tallgrass prairies near Windsor, Ontario, although the three Canadian prairie provinces are discussed in some chapters.

Part three describes the animals that evolved on the prairies. As well as finding chapters on the more glamorous mammals and birds, readers will also find chapters dealing with fish and aquatic species, amphibians and reptiles, and perhaps least glamorous but most important of all, invertebrates. It was interesting to learn that the number of grasshopper species rivals the number of bird species in North America.

The last part of the book deals extensively with prairie conservation and the various initiatives, partnerships, and programs that have evolved and are continuing to evolve in the prairie region. It details some of the success stories — and many of the problems are detailed, and examines the effects of agricultural programs and subsidies. A common theme recurs throughout this section: because most remaining prairie is in private hands, successful conservation initiatives must include landowners as an integral part of the planning process and sustainable agricultural practices as part of the solution.

This book will be relevant to anyone who has an interest in the prairie and its extensive bibliography is an excellent source of references for further reading. Inclusion of some Canadian data is welcome and will make the book more useful in the northern prairies. With over 40 contributors to the various chapters, the book provides a comprehensive look at the past, present, and most importantly, the future of this diverse ecosystem.

Marilyn J. Latta, Habitat Conservation Committee, Manitoba Naturalists Society, Winnipeg, Manitoba, Canada.

Last harvest: The genetic gamble that threatens to destroy American agriculture

By Paul Raeburn. 1995. University of Nebraska Press, Lincoln NE, US. Paper ISBN 0-8032-8962-2, $12.00. 272 pp.

The conservation of plant biodiversity

By Otto H. Frankel, Anthony H.D. Brown and Jeremy J. Burdon. 1995. Cambridge University Press. Paper ISBN 0-521-46731-4, $27.95. 320 pp.

These two books, the first written by the science editor for Associated Press and the second by a group working in the Division of Plant Industry, CSIRO, Canberra, Australia, complement each other well in that they present contrasting views on biodiversity and conservation. Paul Raeburn conveys a strong political and educational message, while Otto Frankel and his colleagues have provided a more detached and scientific analysis of the complex problems of plant conservation. Both books stress the need for the preservation of biodiversity both in nature and in germplasm banks and are concerned with the difficulty of obtaining a fully representative sample of germplasm for a species. Although Frankel and his colleagues have developed a rationale to determine the minimal sample size (referred to as the "core collection"), variations among individuals in a plant population can be extreme with respect to common features such as height, gain, and fruit production. Since it is impractical to store more than a fraction of the available germplasm inside a bank, the plea in both books to conserve stocks of important crops in nature as "landraces" is particularly well-timed. The recent "Seeds of Survival" program in Ethiopia, funded by Canadian agencies, is an example of how such an idea has been carried out successfully.

One of the main reasons to conserve germplasm, in whatever form, is to be able to tap into a plentiful source of genes to counteract unforeseen physical and biological challenges, particularly the sudden overwhelming appearance of a new pest. Both books condemn breeding programs that produce crop varieties in which a few outstanding characteristics are retained and developed at the expense of a larger gene pool whose value is not immediately obvious. [This problem is magnified by the widespread use of these varieties in place of local varieties and landraces that are adapted to their environment. But when broadly based, germplasm banks can also help to restore wild ecosystems, such as prairies, along with the help of botanical gardens and other resources. *Ed.*]

Paul Raeburn is deeply concerned at the current neglect and deterioration of the US National Plant Germplasm System, which appears to have departed from the ideals of the IBPGR (International Board for Plant Genetic Resources) and the IPGRI (International Plant Genetic Resources Institute) as outlined by Frankel and his colleagues. Attribution of blame to senior officials and politicians within the US Department of Agriculture seems to be justified, and should serve as a warning to counterparts in Canada and in other countries that are responsible for the preservation of large collections of germplasm.

The implications of the current mass extinction of many plant and animal species are brought out particularly well in "Last Harvest" (chapter 5), as is the current failure to grasp the magnitude of the problem. Perhaps a lack of awareness of the complex interdependence of many species as well as their adaptation to specific ecological niches are responsible for the lack of progress in curtailing humanity's progressive destruction of habitat. Raeburn's observation, "The tragedy of the current episode is that humans are here not only to experience it, they're also responsible," holds true for this and other misguided activities. He shows how dwindling agricultural production and the needs of a growing human population could combine with other factors, such as misuse of land, water, fertilizers, and pesticides, global warming, and ozone depletion, to cause a widespread human and environmental disaster.

Apart from working towards a change in policy by alerting the public and the politicians alike to the dangers mentioned above, Raeburn offers few solutions. He implicitly recommends control of population growth but does not discuss it at length. Chapter 7 ("Hard Science, Soft Farming, A Way Out?") discusses the virtues of alternative and environmentally beneficial agricultural systems, such as organic farming and other low-input sustainable forms of agriculture. Some aspects of genetic engineering are also recommended as a magical way of putting to best use the genes that are available within crop populations. These new strategies are excellent but by themselves are probably not enough to avert catastrophe unless widespread reform takes place elsewhere.

The Conservation of Plant Diversity addresses in considerable scientific detail the problems concerning both the conservation of threatened and endangered plants on one hand, and of entire plant communities on the other. The reason for conservation, as the first chapter makes clear, is to preserve forms of life in their natural state so that they may continue to evolve. Part of the value of the book lies in the authors' attempts to clarify or quantify a number of complex key issues, such as the measurement and value of biodiversity, the choice of species and plant populations that should be targeted for conservation *in situ*, and the minimum number of a species needed to form a viable population. Particular attention is given to the crucial demographic and other risk factors that plant populations must overcome in order to survive. Included in this discussion are the peculiarities of sexual reproduction of plants that can result in a frequency and intensity of inbreeding far greater than in animals, leading in turn to a decrease in growth rate, survival, or fertility.

The authors show convincingly, and in a generally readable fashion, how an informed and logical decision-making process can strengthen scientific attempts to conserve flora and fauna against competing economic, cultural, and ethical claims. The choice of which areas to protect can be as complex as the determination of individual species, since interactions between flora and fauna have to be taken into account. A reserve devoted to a plant community must also be able to cope with various abiotic and biotic threats, including global warming, fire, and invasive plants and pathogens. Particularly interesting is the authors' discussion of the use of ecological attributes in pattern analysis as part of the process of choosing the best set of sites for a system of reserves (pp. 230–231). Provision of corridors linking reserves to facilitate movement of plants and animals might be practicable in some cases where the communities are relatively small. However, there may not be a solution for communities that have evolved in tandem with large migratory herbivores, as in Africa, or those that are under too great a pressure from humans.

These books are well written and I congratulate the authors on their skill in presenting several complex subjects. Of the two volumes, *Last Harvest* is perhaps more accessible to the general public. Those with a mathematical background will appreciate the elegance of the theoretical models in chapter 5 of *The Conservation of Plant Biodiversity* and elsewhere, but a less scientific reader might prefer more focus on the experimental evidence backing up the authors' arguments.

Dr. Philip Martin (Ottawa, Ontario, Canada) is a mycologist and plant pathologist, interested in issues concerning biodiversity and the environment. He has lived in Southern Africa and in Canada.

FORUM, continued from page 27

regeneration. These practices do not imitate natural disturbances. Ecoforestry works with the natural disturbance regimes specific to particular landscapes and watersheds. What is appropriate practice and use in one forest type is often not in another. Thus, ecoforesters are committed to living in, working in, and learning from their forests over the long term.

6. The authors note that Canada has regulations to protect biodiversity. However, many of these are not fully implemented. Industry domination of forests for fibre and timber has not been changed by them. The demand to meet large annual allowable cuts clashes with efforts to preserve biodiversity. Forests provide many services, interests and values, but these cannot flourish given huge demands for wood fibre and timber. Large scale industrial forestry is one of the major causes of loss of biodiversity.

7. We agree, there is no one right way to manage all forests everywhere. This is why the large-scale, industrial model must be replaced by diversified ecoforestry approaches based on private forest land uses, new forms of tenure, community forests, diversified forest economies, cooperatives, small companies, Aboriginal forest traditions, etc. *We must diversify and democratize the forest industry and economy in Canada, and shift to ecological paradigms and comprehensive values driven approaches.*

8. We applaud the pulp and paper industry's better use of energy, increased recycling, and use of other fibres. We hope they also support diversification of local economies and ecologically responsible forest use.

THE LAST WORD

Under the Antarctic Ice

Diving through a tidal crack in the 2 metre thick antarctic sea ice, I am struck by the calm of the underwater environment, not by its cold and hostility. This is not surprising, considering that the wind chill above is -40°C and the wind is whipping a gale of ice pebbles in my face before I descend. I pity my dive tender who must stay by my entry point until I return. For now I am in league with the Weddell seals that glide around me. They spend the whole antarctic winter under the sea ice, returning to tidal cracks only to catch lungfuls of air. Underwater, the temperature barely varies a tenth of a degree from -1.8°C the whole year through.

I am diving in McMurdo Sound at 77° south latitude in the Ross Sea of Antarctica. It is late November, and the seals are meeting to mate. I can hear the males calling through the water, long siren-like wails that trail into deep groans, grunts, and clicks. The calls vibrate my body.

Carpeting the seabed are hundreds of red stars and urchins. Ribbon worms mass into gorgonian coils, competing for seal feces. Sea spiders tiptoe methodically between, and spiky, sausage-like polychaetes wander with them, engulfing small scraps. Deeper, beyond the enriching influence of the seals, grow a mass of sponges, anemones, fan worms, tunicates, and hydroids, all capturing tiny plankton and detritus from the water.

In Antarctica it is boom and bust. December's summer sun stimulates a huge bloom of phytoplankton, which feeds jellyfish and angel-winged sea butterflies in the water column, as well as the host of animals living on the bottom. Worms and crustaceans feed the fish, and the fish feed the seals. Come February the bloom will disappear and the water will become so clear that visibility for divers will be an astounding 200 metres.

As I drift through the neon blue crystal caverns that the seals claim as their mating grounds, I discover one small seal that never made it. It has frozen, suspended on the seabed. It forms a metre high statue, its hind flippers glued into the sediment by anchor ice. Sea stars cluster at its base, giving it a red pedestal. The seal stares distantly down the cavern. I wonder whether it had lost its way and had not been able to reach a breathing hole in time.

Returning to my entry point, I see my tender bending down to catch a glimpse of what I have been so privileged to see. His red parka is caked in snow. I can see the blizzard buffet him. I am tempted to turn tail and return to the seals.

Kathleen Conlan,
Canadian Museum of Nature scientist and
recipient of a National Science Foundation grant,
McMurdo Station, Antarctica

A few words about the Canadian Museum of Nature

The origins of the Canadian Museum of Nature (CMN) were formed within the Geological Survey of Canada in 1842. Over 150 years later, the CMN has some 10 million specimens in its collection, which still represents only half the known species in this country, and an active team of scientists, collection managers, education specialists, and business experts.

The CMN's mandate is to increase knowledge and understanding of, appreciation and respect for, and interest in the natural world. This role has never been more crucial, as the demand for environmental harmony between the world's burgeoning human population and nature reaches a critical point. For more information about the Museum's activities, please contact Joanne Charette, Corporate Communications at (613) 566-4249.

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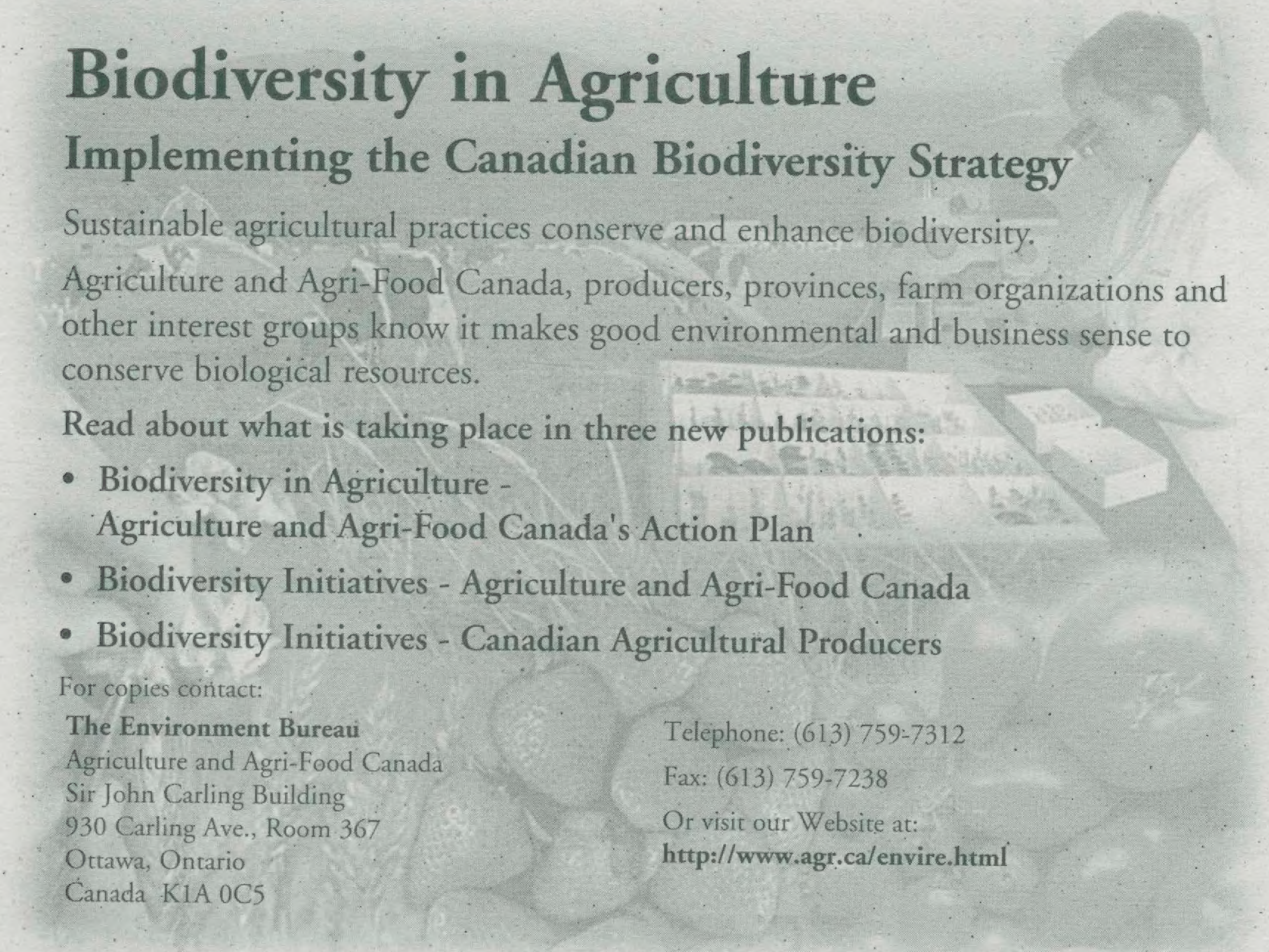

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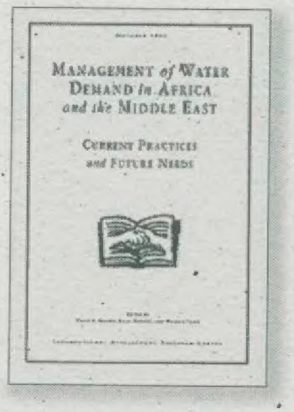

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Chironomid midge
Chironomus plumosus (Linnaeus)

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